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Operative Surgery

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TO MY MOTHER AND TO MY WIFE

The qualifications required for the surgeon are four first, he should be well educated second, he should be skillful third he should be ingenious, and fourth, he should be adaptable. For the first, it is necessary that the surgeon should know not only the principles of surgery but also those of medicine in theory and practice for the second that he should have seen others operate, for the third that he should have good judgment and memory to recognize conditions and for the fourth, that he be able to accommodate himself to circumstances Let the surgeon be bold in all safe things, and fearful in dangerous things let him avoid all evil treatments and practices Let him be gracious to the sick, considerate to his associates, cautious in his predictions Let him be modest, sober gentle pitiful, merciful not covetous nor extortionate- but rather let his reward be according to his work, to the means of the patient, to the issue of the disease, and to his own dignity

Ars Chirugica. Guy de Chauliac, A.D. 1363.

Preface

THE objective of the author has been to provide a single volume work on general surgery in which the gross appearance of surgical lesions is described, the proper treatment is indicated, and detailed description of operative procedures is given. Except for the notes on preoperative and postoperative care this is purely an operative surgery and pathologic conditions are described as they are encountered at the operating table Indications for surgery preoperative diagnosis and anesthesia are not discussed, and micropathology is mentioned only when necessary to clarify an essential point in differential diagnosis Gross pathology should be as familiar to the surgeon as to the pathologist, but the mere fact that, in most cases, carcinoma of the breast can be diagnosed by looking at it, or carcinoma of the pancreas by feeling it, does not mean that the surgeon should depend on gross appearance alone. Facilities for making frozen sections and the services of a pathologist must be available and fully utilized.

In suggesting the operation most suitable for a given lesion the author has attempted to correlate that lesion with the findings in other organs In gallbladder disease for instance, the procedure must be determined not by examining the gallbladder alone but by evaluating the condition of the entire biliary system moreover after general abdominal exploration, the surgeon may find another surgical lesion of even more importance than that of the gallbladder Even with the most skilful preoperative examination such unexpected findings are not rare but their incidence is exaggerated and they are given special emphasis in this book because they so often present a problem in surgical procedure. Although good surgical judgment is gained primarily by training and experience there are many principles, well known to the mature surgeon, that can be explained to the advantage of the younger man.

The operations described are those that the author has found to be most satisfactory in his own experience in general surgery and the highly technical procedures of specialized fields have been omitted Emphasis

has been placed on anatomic names rather than proper names for operations, and individual idiosyncrasies of technique have been avoided as much as possible.

The book is designed for the intern, resident, and less experienced surgeon and, although it does not claim originality of material, a different approach has been attempted whenever possible Nothing has been included that does not have a practical application. No references to the current periodical literature are cited, since they are so easily available elsewhere

I wish to thank the illustrators Miss Dorothy L. Booth and Mr William Brown McNett, for their co-operation, and my secretary Miss Alyce L. Boleski, for her assistance I wish also to express my appreciation to the Oxford University Press for their courtesy and helpfulness.

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Foreword

There is no book, or series of books on any single subject of medicine that can supply answers to all questions that may come to mind in the care of an individual patient. Once one has selected the profession of medicine as a life's work, however, in the same breath has one assumed the responsibility of lifelong study despite the quantity of active experience one has enjoyed.

Study naturally includes the reading of current literature and books. One has a right to expect of reputable recognized medical journals that the articles published have been culled but, as is true of talks, it is well to be mindful of the fact that expressed views are the author's own and not necessarily the only views of the subject.

When a reputable and recognized surgeon undertakes the task of writing a book on surgery he undoubtedly does so with the feeling that he is filling a need. If old and new knowledge can be, as in this work, tabulated and consolidated, digested and redigested, on the basis of long experience, and then reformed in such a manner that each surgical entity is dealt with concisely and yet the relationship of that entity to the entire body is not lost sight of then a worthy book has been written.

In the final analysis, the real value of a book depends on who reads it and how helpful it is to the reader It is the hope of the author and the expectation of the writer of this foreword that *Operative Surgery* will be widely read by students of medicine and surgery and that it will aid in a better understanding of surgical problems.

Charles W Mayo

OPERATIVE SURGERY

CHAPTER I

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Preoperative Treatment

SURGICAL OBJECTIVES

Understandably a surgical operation is an unforgettable event to most patients not only because it takes a degree of courage rarely called for in a quiet life but also unfortunately because it is likely to be an unpleasant episode. Nearly all operations entail a certain amount of risk, and some of them, of course are highly dangerous. One may marvel at the reserve of fortitude upon which most men and women can call when it is needed. The risk should not be stressed by the surgeon when talking to the patient but it should not be minimized when the patient asks for a frank statement about his prospects An operation at best is an uncomfortable ordeal, and, from the patient s point of view it is to be endured only as a substitute for a condition that is or may become even more unpleasant. This does not mean that a major operation necessarily causes a great deal of suffering and one that is properly managed seldom does but there are certain unavoidable discomforts associated with the incision, the confinement, and the helplessness Also the usually unforseen expense and the concern for those left at home are often disturbing to the patient s peace of mind. He expects the cure or alleviation of his disease if this is humanly possible, and he naturally assumes that there will be no unnecessary mutilation or removal of organs. He relies on the surgeon s judgment with a confidence that should not be unjustified.

To the surgeon is given the opportunity of curing diseases that otherwise would cause suffering or death. He can gain no greater satisfaction than that which comes when his work is well done Deep personal concern on the part of the surgeon in each individual case leads naturally to a wholesome doctor-patient relationship and an attempt on the part of the surgeon to inspire the patient s confidence on any other basis than this is doomed to failure

To the intern, each patient provides a new opportunity for advancing his knowledge. Every patient is interesting, and every example of a disease differs from all others but a thorough interview and painstaking

examination are necessary to bring out those aspects of a case that are most important from the scientific and humanitarian points of view

MAKING THE DIAGNOSIS

It is impossible for a good surgeon to be a poor diagnostician because the same characteristics that make the one are required by the other Scientific knowledge good judgment painstaking care and technical skill are applicable as much in taking the history and doing the physical examination as they are in performing the operation. If surgery were a handicraft instead of a science and an art, it might be possible to separate diagnostic acumen from surgical ability and even place the former on a higher plane but fortunately this is not yet true A careful history is taken on each patient with particular attention being paid to previous operations If the patient does not know the nature of an operation that he has had previously it is usually possible to get the information from the doctor who performed it or the hospital in which it was done A complete physical examination should never be omitted, but in the sick patient it should be done as gently as possible and with exposure of only one part of the body at a time A complete urinalysis and blood count, with hemoglobin determination and examination of the stained smears, should be done on every patient A flocculation test for syphilis should be made as a matter of routine, and an X ray of the chest is desirable unless the condition is one that requires immediate surgery Other laboratory investigations, such as kidney function tests, gastric analysis serum protein determination electrocardiogram, bleeding and clotting time, and icterus index are ordered when there is some particular indication that they are necessary Any abnormal finding in the history physical examination, or laboratory reports is an indication for review of the case before the operation.

Diagnosis should include not only the lesion for which the operation is to be performed, but other conditions that may be present and that affect the surgical risk. The surgeon should try to classify the patient as a good fair or poor risk, and it is well to estimate the general percentage of mortality in the particular operation, but the figure should seldom of course be given to the patient. A person about to undergo an operation is not able to consider dispassionately such statistical information, his interest is purely personal, and the mortality of a given operation to him is either zero or 100 per cent.

GENERAL PREOPERATIVE MEASURES

The Good Risk Patient

The amount of preoperative preparation and the length of preoperative stay in the hospital depends largely on the classification in which the

patient is placed, since the patient who is but a poor or fair risk will usually require more treatment before surgery is done. The preparation necessary in the good risk patient depends, of course, on the type of operation. This is considered specifically in the following chapters, but certain general measures are common to all. Unless the operation is an emergency the patient should be in the hospital at least sixteen hours before surgery and a longer period of time is desirable. On the day before surgery unless there is some particular contraindication, the patient is allowed to eat the regular hospital diet. On the morning of surgery nothing by mouth is permitted. An enema is given the night before operation, but no cathartic should be administered. The skin in the region of the proposed incision and for a generous distance around it is cleansed with soap and water and shaved. For an abdominal incision, the area prepared includes the entire abdomen from the ensiform cartilage down to and including the pubic region. After the region has been shaved, it is again cleaned with soap and water In the case of the abdomen, the umbilicus is given particular attention. The soap and water are rinsed off and alcohol is then applied with sponges. Just before the operation the skin is again cleaned with alcohol followed by ether and two coats of antiseptic are painted on. The antiseptic should be applied liberally and any potentially infected area should be painted last and the sponge immediately discarded. If there is a lesion in the operative field that cannot be thoroughly cleaned or sterilized, it should be cleaned as well as possible painted with an antiseptic, and then walled off by gauze and rubber tissue, held in place by towel clamps or sutures.

Preoperative Sedatives

Sodium pentobarbital or seconal grs 1½ to 3 is given at bedtime to most adult patients and repeated two hours before operation. One hour before operation morphine sulphate grs. ⅙ to ¼ and atropine sulphate grs. 1/150 are administered Morphine should not be given to children under two years of age but for older children appropriate doses of morphine and atropine can be used. In the case of emergency operation it is necessary to omit all except the last medication. In the aged or debilitated, smaller doses of all sedative drugs must be used.

CONDITIONS REQUIRING SPECIAL TREATMENT

Anemia

Secondary anemia is extremely common in surgical patients and contributes as much as any other factor to making the patient a poor risk. Except when there is continuous loss of blood, no means should be spared to bring the hemoglobin value up to at least 60 per cent, and the erythrocyte count up to a minimum of 3,500 000 before surgery is done.

In cases with continued hemorrhage, such as may occur with a carcinoma of the colon, blood may be lost as fast as it can be restored, and one must be content with giving blood during the operation and in the immediate postoperative period. To build up the blood, nothing is more effective than whole blood transfusions, given as often and in such amounts as are necessary. Where an unlimited length of time may be used to prepare the patient, ferrous sulphate is administered by mouth, reinforced as required with blood transfusions, and the hemoglobin and erythrocyte values should be brought up to a nearly normal level. Transfusions of concentrated erythrocytes are valuable when it is particularly desired to elevate the hemoglobin.

Dehydration

When there is loss of body fluids as indicated by dry tongue and skin and sunken facies the dehydration may be a simple water privation, or there may in addition, be loss of plasma or chlorides or both. With loss of blood chlorides there is often alkalosis with a high carbon-dioxide combining power. Laboratory investigations may shown high erythrocyte values even in the presence of anemia, concentration of blood proteins with an increased protein nitrogen, concentrated urine, and high hematocrit readings. With vomiting or an intestinal fistula, there is loss of chlorides, as there is also in burns. In burns there is loss of plasma, and body proteins are lost with the drainage from an empyema cavity.

In the treatment, these other factors that complicate the simple dehydration should be taken into consideration. Electrolytes are restored by the administration of physiologic saline or Ringer's solution plasma or whole blood transfusions are used to restore protein loss, and protein digests are also helpful. Caution should be used in the administration of saline solution, however since, with lowered serum proteins, excess salt may result in edema. One should bear in mind that water is lost in perspiration and in the excreted urine amounting to from 2000 to 2500 cc. per day in the uncomplicated case, and to 3500 cc. or more in the very sick patient. As this must be replaced before the previously lost fluids can be built up, it may require several days to restore the patient to normal. If there is no abnormal loss of electrolytes 1000 cc. of normal saline solution provides the daily requirement, and other fluid should be given in the form of glucose in distilled water. If the patient is able to retain and absorb fluids taken by mouth, little parenteral fluid may be necessary. Water in the form of 5 per cent glucose, or saline solution may be given subcutaneously with excellent absorption, although the process takes longer and is usually less convenient than the intravenous method. Fluids may also be given by proctoclysis, but here absorption is less certain.

Hypoproteinemia

Lowered plasma, globulin, and particularly albumen may result in edema, cause suppression of kidney function, and interfere with wound healing Hypoproteinemia is often associated with anemia and dehydration, and the administration of saline solution to correct the dehydration may precipitate the appearance of edema. Lowered serum proteins should be replaced by the administration of whole blood, blood plasma, or protein hydrolysates if sufficient protein cannot be taken by mouth.

Acidosis and Alkalosis

The loss of body fluids by vomiting, intestinal fistula, diarrhea, bile drainage or from burned areas causes the loss not only of proteins and water but also chlorides with resulting changes in the acid base content of the blood. The loss of chlorides by vomiting causes alkalosis, for which the treatment is the restoration of the chlorides to a normal level, usually by the intravenous injection of normal saline solution. Prolonged diarrhea or intestinal or biliary drainage by the loss of electrolytes causes a relative increase of chlorides in the blood and acidosis. In this condition, also the injection of normal saline solution will supply the lost sodium, and the unneeded chlorides will be excreted. Prolonged starvation may result in ketosis, with presence of acetone bodies in the urine. With the administration of glucose carbohydrate is provided for complete fat metabolism.

Malnutrition

Whether from defective absorption of food or from inadequate intake, nutritional disorders are common in surgical patients. Simple malnutrition is the usual finding but there may be evidence of deficiency in the intake of vitamins B or C The diet should be increased or changed, or the method of intake should be altered, to provide a liberal, well balanced diet reinforced with the needed vitamins. The oral route is to be preferred, but if this is not practical amino acids glucose, and plasma can be given intravenously and the vitamins by hypodermic injection or by venaclysis. Occasionally tube feeding may be necessary in the debilitated patient. In all cases, an attempt should be made, by supplying 5000 calories or more a day to restore some of the lost weight before surgery is done.

Hypoprothrombinemia

The treatment for this condition is discussed under the preoperative preparation for operations on the gallbladder and bile ducts (page 250)

Shock

The treatment of shock takes precedence over any surgical operation, unless it be the control of hemorrhage. The patient should be disturbed

as little as possible and the body heat should be conserved by the liberal use of blankets and hot water bottles Morphine is given for pain and blood concentration with fluid loss is corrected by transfusions of whole blood or plasma If there has been hemorrhage whole blood is preferable If neither of these is available 6 per cent solution of gelatin is used The use of plasma in the treatment of shock due to burns is discussed in the chapter on The Skin and Subcutaneous Tissue

COEXISTING DISEASES

Oral Infections

The presence of infection in the mouth in the form of Vincent s angina, severe pyorrhea, abscessed teeth, or any form of stomatitis increases the danger of postoperative pulmonary infection The milder forms of in fection can be controlled by a few days local treatment before operation but if extensive dental work is necessary operation should be postponed, whenever possible until the work has been done, and the gums are healed.

Respiratory Disease

If the patient is suffering from an acute upper-respiratory infection, operation should be postponed if possible until at least two weeks after complete cure. If postponement is not practical penicillin therapy should be begun immediately and continued after surgery

When chronic disease of the lung, such as tuberculosis, is present in a patient, all general measures are used to bring about maximum improvement in his physical condition before an elective operation is performed, if possible, the time for operation should be set when the pulmonary condition is in a quiescent phase. Inhalation anesthesia, especially ether should be avoided.

Syphilis

Patients with primary or secondary syphilis are a dangerous source of infection and no operation should be undertaken unless absolutely neces sary until the disease is under control. In tertiary syphilis, the risk of the operation is affected not by the presence of a positive blood test, but by any organic lesion that may have been produced by the disease. Elective operations should not be performed, however until antisyphilitis treat ment has been given.

Obesity

Because of the high incidence of postoperative complications, such as pneumonia, ileus vomiting, and disruption of the wound, every attempt should be made to encourage the obese patient to lose weight

before operation is done. As the cardiac reserve of the overweight patient is low the procedure in any necessary operation should be made as short and simple as possible

Diabetes

If the operation is not an emergency one the diabetic patient should be hospitalized and ample time should be taken to get the diabetes under control by diet and by insulin if necessary If the diabetes is not severe and can be controlled without use of insulin, after several days the glycogen reserve in the liver should be reasonably adequate and no special preoperative preparation is necessary Breakfast is omitted on the morning of operation, as in other surgical cases. In the more severe diabetics, breakfast is omitted, but the amount of carbohydrate usually given for breakfast is administered intravenously in the form of glucose solution some three hours before operation, and the usual dose of insulin is given at the same time. The amount of glucose given intravenously should not ordinarily exceed 100 gm., but if some glucose is not given preoperatively fasting may deplete the carbohydrate stores and result in acidosis. In some cases it may be better to give only half the usual amount of carbohydrate taken for breakfast and half the usual dose of insulin. Another acceptable procedure when the diabetes is under control, and when there is no acidosis and the urine is free or practically free of sugar is to omit breakfast on the morning of operation and give preoperatively protamine-zinc insulin in an amount equal to one-half the usual daily requirement.

When there is surgical emergency and operation must be performed before the diabetes can be controlled, 20 to 100 units of insulin should be administered and 1000 cc. of normal saline solution given intravenously at the same time. If the patient is in coma, it is advisable to postpone the operation in nearly all cases until treatment of the diabetes brings the patient to consciousness but an exception to this rule may be encountered in fulminating infections where the infection itself contributes to the coma.

In other cases in which surgery is not immediately necessary the diabetes may be partly controlled and the acidosis relieved before surgery is done In general the treatment of the surgical condition is the important consideration, and operation should not be postponed to improve the diabetic condition at the cost of higher mortality from the surgical disease.

Nephritis and Hypertension

In patients with nephritis or hypertension, the degree of kidney impairment should be determined before operation and every attempt should be made to obtain optimum renal action before surgery The phenolsulfonphthalein test, urine concentration test, and determination of

the non protein nitrogen of the blood give an adequate idea of the functional condition of the kidneys Nitrogen retention or acidosis should be eliminated if possible by increasing the fluid intake and reducing the intake of proteins to 50 gm. per day The urine output should exceed 500 cc. The salt intake should usually be kept to 8 gm. per day In the presence of anemia not relieved by the administration of iron transfusions are indicated

When acute nephritis is present surgery should be deferred, if possible until the acute process has subsided In patients with chronic nephritis and severe impairment of kidney function, the operative procedures should be made as short and simple as possible

When a patient is suffering from hypertension, apprehension excitement, pain, and struggling during anesthesia are to be kept to a minimum.

Heart Disease

Whenever possible the patient with heart disease should be given several days rest before operation, and during this time every effort should be made to evaluate the condition of the heart in order to determine the optimum time for operation and the magnitude of the operation the patient can stand. Fluids when given intravenously should be injected in amounts not over 500 cc. at a time, and the injections should be made slowly· this also applies to transfusions Every effort should be made to allay the patient's apprehension and to avoid anything that would cause pain or excitement. Congestive heart failure should be relieved before operation whenever possible otherwise any operation done should be a minimal procedure. Digitalis is usually indicated in congestive heart failure and auricular fibrillation When heart block or persistent auricular fibrillation or flutter are present, the risk of surgery is increased.

The presence of coronary thrombosis is a contra indication to any surgery unless absolutely necessary and a past history of coronary thrombosis considerably increases the operative risk. When an operation is necessary it should be postponed if possible until at least three months after the last previous attack. Attacks of anginal pain even without coronary thrombosis should lead the surgeon to keep the operative procedure short and simple although in some cases an exception may be made to remove a diseased organ, such as a gallbladder in the hope that it will reduce the incidence of anginal attacks An X ray of the chest and electrocardiographic tracings should be made routinely in these patients

Chronic Sepsis

Patients who have had a prolonged infection are poor surgical risks and every attempt should be made to get them in as good condition as possible before operation. Secondary anemia is almost always present and should be treated by blood transfusions Penicillin or sulfonamide

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therapy should be used to the point of maximum improvement. The nutrition should be improved by the use of an adequate diet with supplemental feedings of glucose, amino acids and vitamins administered if necessary by the intravenous route. With adequate fluid intake the renal function, which may have been impaired, usually improves and nitrogen retention is decreased.

CHAPTER II

General Considerations

General Considerations

The responsibility of the surgeon begins as soon as the patient is brought in to be placed on the operating table, since the proper positioning of the patient contributes a great deal to the ease of performance of an operation

POSITIONS

Dorsal Recumbent Position

For the dorsal recumbent position, the top of the patient s head should be even with the end of the table, a blanket placed over the body and the restraining strap placed across the thighs just above the knees and on top of the blanket. The strap should be pulled up snug but not tight. The patient s position should be adjusted to conform with the desired position of the kidney rest, if one attached to the table is to be used, but when sandbags are used the patient s head can be placed even with the end of the table as usual. The arms should be extended along the side of the body and the wrists held in padded wrist bands attached to the table. The elbows should not be allowed to rest on any hard part of the table without interposed padding If an operation such as a radical amputation of the breast is to be performed, the patient s arm on the involved side is extended on an arm board, to which it is fastened with a bandage around the wrist. The arm board should make an obtuse angle with the body

Trendelenburg Position

If the patient is to be placed in the Trendelenburg position after he is anesthetized for an operation on the pelvic organs, he should be so adjusted on the table that the bend of the knees comes exactly over the break in the table, without regard to the position of the head. Shoulder braces are adjusted at the appropriate level, unless care is used in padding them partial or complete ulnar nerve paralysis is apt to occur

Thyroidectomy Position

For thyroidectomy in which the table is to be in a semi-erect position with the headrest dropped backward enough to hyperextend the neck, the head is adjusted at the appropriate level on the table and a footrest is applied so that the feet rest comfortably upon it.

Lithotomy Position

For perineal work, the anesthetic is administered with the patient in the dorsal recumbent position A Kelly pad is put on the table under the buttocks The strap is placed as usual across the thighs, but the arms, instead of being placed in the restraints, are folded over the chest and held there by the lower end of the shirt, which is pulled up and tucked in. When relaxation has occurred, the strap is removed the lower end of the table is dropped and the patient and mattress are pulled down until the perineum projects over the end of the table, and the feet are placed in stirrups.

(Other special positions are described under the operations in which they are used.)

If it seems likely that intravenous fluids may have to be given during the operation when the patient is asleep one foot is exposed and a needle is inserted into one of the prominent veins. This is connected to a bottle of normal saline solution and the rate of flow is adjusted to a slow drip

PREPARATION OF THE FIELD

Whenever possible before the patient is brought to the operating room the skin is scrupulously cleaned with soap and water and the hair is shaved from the region to be operated on and well around it. In some cases such as compound fractures, it may be necessary to wait until the patient is under the anesthetic before this can be done

In the case of the abdomen, the operative field is exposed by turning the blanket down to the pubic region and adjusting the folds smoothly across the thighs. A towel is laid over the upper part of the blanket, and as the blanket is lifted up the edge of the towel is turned under The skin is scrubbed with ether and two coats of an antiseptic solution are painted on. If iodine is used, only one application is necessary and it is removed with alcohol. For an abdominal operation, the entire abdomen from the costal cartilages to the symphysis should be thus prepared. For a breast operation the prepared field should include the upper part of the arm, the lower part of the neck, two-thirds of the anterior aspect of the chest, and the abdomen down to the umbilicus. For a thyroidectomy the antiseptic should be applied from the point of the chin out over both shoulders and well down over the anterior aspect of the chest. In a

perineal operation the skin of the inner aspect of the upper half of the thighs the perineum, vagina and anus should be included A sponge used to apply antiseptic to the anus or to any potentially infected area should be immediately discarded and not used on any other part of the skin. Antiseptic should be applied liberally beginning in the region where the incision is to be made and working peripherally It is better to prepare too large an area than too small. With most antiseptics in common use, it is not advisable to do much rubbing, since they have a tendency to irritate the skin.

DRAPING THE PATIENT

The surgeon and his assistants who wear masks covering both nose and mouth and who have thoroughly scrubbed hands and forearms, put on gown and gloves without touching them on the outside and proceed to drape the patient. In some hospitals it is the custom for the assistant to don gloves and mask only do the draping with the assistance of the nurses and then remove the gloves and put on the gown and a clean pair of gloves Four longitudinally folded towels are laid in such a way that they surround the operative field, another towel is laid on the tray attached to the table and a laparotomy sheet is draped over the tray and patient, with the opening in the sheet adjusted to expose the operative field. The anesthetist catches the upper end of the sheet and arranges it over the screen. Towels and laparotomy sheet are clipped to the skin with towel clips in such a way as to leave only a neat rectangle of uncovered skin at the site of the proposed incision.

GENERAL PRINCIPLES

When the patient is in sufficient depth of anesthesia as shown by relaxation of the abdominal muscles the operation is begun The instrument nurse should be requested to have a suction machine ready if there is reason to believe it will be needed, and for operations that require electrocoagulation the machine should be in the operating room with the wires and electrodes on the instrument table.

It is one of the duties of the surgical nurse to count the sponges before and after operation, but it is well to remember that if the surgeon never lets go of a sponge while it is in the wound, no sponge will ever be lost there If packing is necessary to control hemorrhage or to expose the field, large gauze packs with tapes to which a hemostat can be clipped should be used instead of sponges The end of the tape and the hemostat are always left outside the wound Absorbable sponges of gelatin or treated gauze are useful when there is troublesome bleeding If the operation is about to be concluded and the nurse reports that a sponge is missing the wound should be re-opened and search made for it until it is found If the sponge cannot be found and one is fortunate enough to be

using the type that has a radiopaque marking incorporated in it, X ray photographs should be taken immediately, and the operation not concluded until the sponge if present is removed.

When hot moist packs are used the surgeon must ascertain for himself that the pack is not too hot before putting it in the wound or severe damage may result The surgical nurse is of course expected to see that such an accident does not take place but the careful surgeon does not depend on anyone else more than necessary As far as possible he sees to it that there is no break in sterile technique caused by such things as coughing into the wound allowing the gloved hands to drop below the level of the table working with a punctured glove allowing perspiration to drip from the forehead or letting a long ligature hang down over the side of the table He also assures himself that every solution used is exactly what it is supposed to be, and above all if a spark or a cautery is necessary he satisfies himself that the type of anesthetic is such that no explosion can occur

Because of the possibility of a fatal outcome even in what appears to be the most trivial case the surgeon always has uppermost in his mind an appreciation of his own responsibility Levity has no place in an

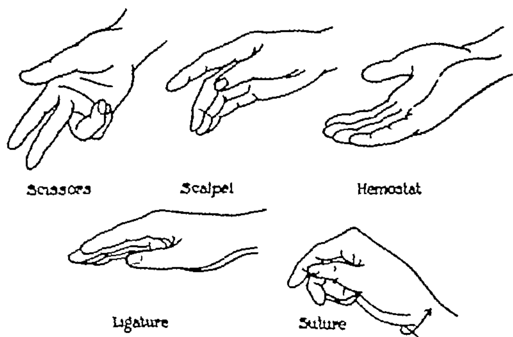


FIG. 1. *Hand Signals for Instruments Ligature and Suture*

operating room, and histrionics or the perpetual display of bad temper is not conducive to efficient work on the part of nurses and assistants Difficult operations unavoidably place the surgeon under considerable tension, but experience and reading should provide him with the helpful knowledge of a situation parallel to the one that confronts him Speed in operating is of only limited value, but equanimity and confidence, which

go with knowledge and skill, make the surgeon's movements purposeful and incisive. In surgery there is rarely need for a lightning decision, and in an unusual case a good surgeon does not hesitate to stop and think before he goes ahead with a procedure that affects the patient's life. A routine method of doing each detail of an operation leads to the quicker training of nurses and assistants and the author has found that the few simple hand signals illustrated in Figure 1 save distracting interruptions during the course of an operation.

DRAINS AND THEIR USE

The usual drain is made of rubber and, in the simplest form, consists of a sheet of thin rubber tissue This may be cut into strips as small as desired or used as a loosely folded sheet or rolled into a tube. The Penrose drain, consisting of this type of rubber tissue in the form of a tube, is manufactured in various sizes. It is a very satisfactory drain and is the one used for most purposes The cigarette drain consists of a soft rubber tube of the Penrose variety through which a wick of plain gauze has been pulled. The gauze provides drainage by capillary action, but is no more effective than the simple tube When a cigarette drain is used, the gauze should be cut off even with the end of the tube and no threads should be allowed to project in such a way as to become adherent in the wound. Another type of drain very useful for the drainage of a cavity is the rubber tube This may be fenestrated near the end if desired. Plain gauze in the form of a wick is not recommended for drainage, but it is useful for packing Iodoform gauze is used for the same purpose. The latter has a weak antiseptic action, and its odor may mask a more unpleasant one. When rubber is used for drainage it should be fresh and of the best quality and should be soft and pliable Catheters because of their stiffness, do not make satisfactory drains but are useful when drainage of a hollow viscus is desired, such as in enterostomy No drain should be left in a wound without having a safety pin attached to it to prevent its slipping back into the wound.

The reason for using a drain is to provide a channel that will permit necrotic tissue or fluid to escape to the outside. The necrotic tissue or fluid may be present at the time of the operation, but not removable. For instance there may be a ruptured appendix that cannot be safely taken out, and drains are used in order that the sloughing tissue can find its way to the outside. In the case of abscess cavities, as it is impossible to evacuate the pus completely a drain is used to permit the pus to come out following surgery For this purpose a rubber tube may be more satisfactory than a Penrose drain, since the former provides a large channel, and no damage is likely to be done to the surrounding tissues because the tube is protected by the wall of the abscess. In other cases a drain is used because although no fluid or necrotic tissue is present at the time

of operation it is reasonable to expect that such tissue or fluid will form When there is leakage of bile from the gallbladder bed hemorrhage that cannot be controlled a dead space that cannot be filled or when large raw surfaces are exposed, as is the case in radical amputation of the breast, drainage is a safety measure Not only do drains allow infective material to reach the outside and prevent the development of a septic focus in the tissues but the wound itself is protected from infiltration with resulting suppuration and separation.

In spite of the lifesaving value of drains when properly used it should be borne in mind that they possess certain limitations and disadvantages. In the first place, a drain is a foreign body and as such, predisposes to exudation and infection. Discharge from a wound will never cease if a drain is left in place it must be removed as soon as it has served its purpose. The use of drainage may delay convalescence predispose to hernia because of a weakened wound and produce bowel obstruction or fecal fistula. The area that can be drained is limited since the drain tends very soon to become isolated by the surrounding tissues. It is impossible, for instance, to drain the entire abdominal cavity regardless of the location of the drain or the position of the patient. The indiscriminate use of drains, by mitigating the dangers of careless surgery may cause the surgeon to leave dead spaces that should be closed and bleeding surfaces that should be controlled.

In spite of the disadvantages of drains mentioned above, the author believes that one should not make a fetish of not draining wounds. In many cases, for instance, cholecystectomy can be performed and the wound closed safely without drainage and the same is true after thyroidectomy but, particularly for the beginner the author recommends that in such cases drainage be used. The seriousness of such conditions as peritonitis produced by bile leakage and tracheal compression caused by hemorrhage after thyroidectomy point to the necessity of mature experience before drainage is dispensed with in these operations and in others that have comparable potential hazards.

DUTIES OF ASSISTANT

An efficient assistant should utilize every opportunity to learn the particular methods of the surgeon he is helping, and he should make no suggestions in regard to the method of procedure He should rarely speak unless spoken to except that he may at an appropriate time, usually after the conclusion of the operation, ask the surgeon any questions he wishes about something in the operation that he did not understand. He should remember that the operation is the responsibility of the surgeon and that it is not the assistant s duty to point out such things as bleeding vessels that are perfectly obvious to the surgeon. His most important duties are to keep the field dry and to provide adequate ex

posure, while at the same time he is learning the art of surgery He should be alert to anticipate the moves of the surgeon and he should keep the field exposed not only by proper retraction but by keeping his hands out of the way He must cultivate the ability to sponge gently but firmly by blotting and not wiping, and he must be able to apply a hemostat with speed and accuracy He must be able to get in and get out but, equally important, he must choose the proper time to do so A common fault that may be seen in the most conscientious assistants, in fact more frequently in them than in those who are less willing is the tendency to work at little independent projects during the operation. While the surgeon is attempting to clamp the cystic duct, for instance, the assistant may be engaged in applying a hemostat to a bleeding vessel in the skin. The assistant s intentions are good but he has forgotten that he should give all his attention to the immediate objective of the surgeon.

EMERGENCIES THAT MAY ARISE DURING AN OPERATION

Cessation of Respiration

Control of this emergency rests in the hands of the anesthetist if a gas machine is at hand, but manual artificial respiration may be given. Forcible dilatation of the anal sphincter is a powerful respiratory stim ulant, and drugs that stimulate respiration (coramine, metrazol) should be administered.

Heart Stoppage

If during the course of an abdominal operation, the heart stops beating it should be massaged through the diaphragm. The hand is passed above the left lobe of the liver and by pressing on the diaphragm the heart is squeezed against the overlying chest wall about forty times per minute. Five minims of 1 1000 adrenalin solution may be injected into the wall of the left ventricle by passing a fine needle through the chest wall.

Shock

Falling blood pressure a cold clammy skin, and a rapid weak pulse should be treated by the transfusion of whole blood or plasma. The administration of blood during the course of a major operation will prevent the onset of these symptoms in most cases, and from 500 to 1500 cc. or more should be given as required. Adrenalin or ephedrine should be administered as indicated. Gentle handling of tissues prevention of loss of body heat, and hemostasis reduce the danger of shock, and it is much easier to prevent the condition than to cure it. The surgeon should consult frequently with the anesthetist about the condition of the patient, and this is especially important when he has reached a point where he can either conclude the operation or go ahead with another procedure.

CHAPTER III

Sutures, Ligatures, and Instruments

Sutures, Ligatures, and Instruments

SUTURES

Absorbable Sutures

There are three forms of absorbable suture material in common use catgut, kangaroo tendon and fascia. Catgut may be plain or may be treated with chromic acid or its salts to slow its absorption. There are two types of chromicized catgut, medium chromic and extra chromic. The former resists absorption in muscle for from ten to twenty days, and the extra chromic for a longer period. Absorption of catgut is faster in serous or mucous membranes and slower in tissues of the young, the old, or the debilitated The absorption rate is also influenced by the amount of tissue reaction, the presence or absence of infection, the amount of tension on the wound, and by other unknown factors In using catgut – or any other suture material, for that matter – one should select a size no larger than is necessary to give the required strength to the wound, since the more foreign material put in a wound the more tissue reaction there will be. It has been found that the smaller sizes of catgut are as efficient during the critical period of wound healing as the larger sizes, and there has accordingly been a tendency to abandon the use of the latter If chromicized catgut is used, sizes as small as 0000 and 00000 are effective for intestinal suturing and 0 or 00 for closing the abdominal wall. Extra chromic catgut is of particular value in operations such as vaginal hysterectomy and perineorrhaphy as the local secretions hasten catgut absorption.

Kangaroo tendon, which is prepared from the tail of the kangaroo is slower in absorption than catgut and has a greater tensile strength. It may be used when these characteristics are important, as in holding fragments of bone in apposition.

Fascia lata, which is used in the form of strips or sheets, is of value in the repair of hernia. The most satisfactory fascia is obtained from the patient himself but preserved fascia from the ox is available.

Non Absorbable Sutures

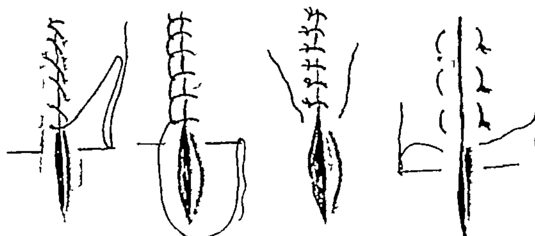
In order to replace catgut with a suture material of more constant and lasting strength and one that produces less tissue reaction, many surgeons use non absorbable material such as silk, cotton stainless steel, and tantalum. Cotton apparently causes less reaction and may be preferable to silk. In order to avoid placing in the wound an excess amount of foreign matter any of the foregoing suture material should be used as interrupted sutures and should be as fine as possible and cut off as close as possible (2 mm.) above the knot. This technique necessitates more careful and more time-consuming work, but if properly used it results in more rapid wound healing It should not be used in the presence of infection. If a wound becomes infected, it may drain for a considerable period of time and extrude suture material at intervals, to the annoyance of patient and surgeon. The principles elaborated by Halsted[1] — the use of fine suture and ligature material, careful attention to hemostasis and gentle handling of tissues — can be applied with advantage regardless of the material used. It is not the author s custom to use non-absorbable suture material as a matter of routine, but rather to reserve it for those operations in which a strong wound is necessary in the interval between the absorption of the catgut and the healing of the tissues — as in some herniorrhaphies, for the ligation of large arteries for the repair of blood vessels, nerves, and tendons and for those cases in which the absence of tissue reaction to catgut is especially important for example wounds of the face.

Tantalum offers the advantage of being an inert substance and exciting very little tissue reaction but its tensile strength is not high and, unless wire of large diameter is used, one must be careful in tying knots to avoid breakage. Other non absorbable suture materials in common use are silver wire, silkworm gut, nylon, dermal, and horsehair all of which are inserted in such a way that they can be removed when the wound is healed.

SUTURING

Common methods of suturing are illustrated in Figure 2 and the drawings are self-explanatory It should be emphasized, however that in placing a suture in the skin, the kind of stitch that is desirable in dressmaking is not suitable. In suturing abdominal wounds the needle should not penetrate the skin edge only but should pass through some of the subcutaneous tissue and emerge through the skin at least 1 cm. away from the margin of the wound. Sutures placed too close together instead of adding strength to the wound, weaken it by causing more foreign-body reaction. In wounds of the face where the cosmetic result is of paramount

1. Halstead, W S 'Ligature and Suture Material, *J.A.M.A.* 60 1119 1913.



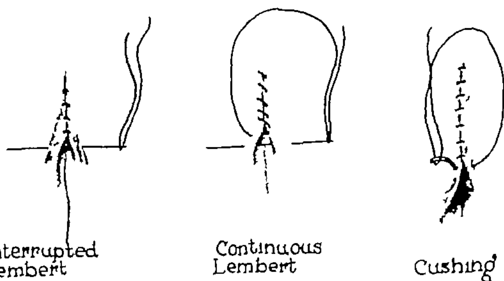


FIG 2A *Sutures.*

importance, the sutures may be placed closer to the edge of the wound. In sewing fascia, skin, or similar structures the stitches should be put in about 1 cm. apart, but in gastrointestinal suturing .5 cm. would perhaps be a more satisfactory distance.

A straight needle that can be used without a needle holder should be chosen wherever possible, since it can be used more rapidly When the needle is inserted, it should be pushed far enough through the tissues so that it can be grasped easily and pulled through with the next move of the surgeon. If the first assistant keeps the suture already inserted under tension by holding it between the thumb and index finger in such a way

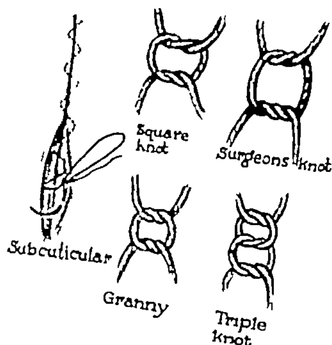
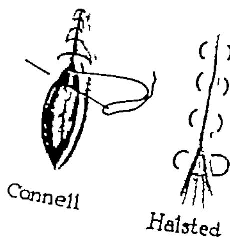


Fig. 2B Sutures and Knots



that when the next suture is pulled up the suture will be pulled from his grasp the procedure is facilitated. When a straight needle is used in gastro-intestinal suturing, it is also helpful to have the assistant grasp the needle when it has been partly pushed through the tissue and pull it out, since the musculature of the bowel is tough and difficult to penetrate

For stitching peritoneum or tissue likely to be torn, needles with a round body should be used, and in all gastro-intestinal work special needles with the catgut swaged on the needle are to be preferred. In skin suturing, the straight Keith needle is commonly used, except in

regions where there is not room to handle a straight needle and a curved cutting needle must be utilized.

Halsted Technique

A large number of needles each threaded with a short length of fine silk (size C) are basted into a piece of muslin for sterilization and storing Halsted used straight needles a great deal, but at present curved needles are more commonly employed. For ligatures 2 or 3 m. of similar silk is wound on each of a number of small glass spools. The surgical nurse, instead of handing the surgeon a piece of silk for tying, gives him one of the spools, which he holds in his left hand while he draws off enough silk for the ligature. By having many needles threaded and a number of spools ready the necessity for threading needles during an operation is largely obviated, but as many as a hundred needles may be necessary Halsted chose to do a great deal of the ligating by transfixion. The vessel is grasped by a hemostat and the needle with the fine silk is passed through or near the vessel, the hemostat is twisted before tying, to prevent bleeding from the puncture wound. All ligatures are drawn only tightly enough to stop hemorrhage and care is used at all times to avoid necrosis of tissue by mass ligation. Fascia, peritoneum, and other tissues, with the exception of skin, are brought together without tension by a series of interrupted sutures each needle is used to insert only one stitch, after which the surgeon is handed another needle with a new length of suture. As each suture is inserted, the two ends are grasped by the assistant and held between the thumb and finger so that at the completion of the suture line all the sutures are held conveniently for tying After all have been tied they are cut just above the knot. Silk should not be used in the same wound with catgut, nor should it bridge over a dead space. A continuous suture of silk is used for the skin, which is covered with one or more layers of silver foil before the dressing is applied.

LIGATURES

Materials used for ligatures may be catgut, silk, cotton, tantalum wire, stainless-steel wire, and occasionally cotton tape. Catgut is more commonly used but causes more tissue reaction than some of the non-absorbable sutures the advantages and disadvantages in general being the same as when used for suturing When one is ligating a large amount of tissue in which important blood vessels are located, a suture ligature should be used. Catgut or other ligature material is threaded on a needle and passed through the pedicle under the clamp The ends are then passed around the end of the clamp and tied once after which they are passed around the other way and tied again. The knot is slowly tightened as the clamp is removed.

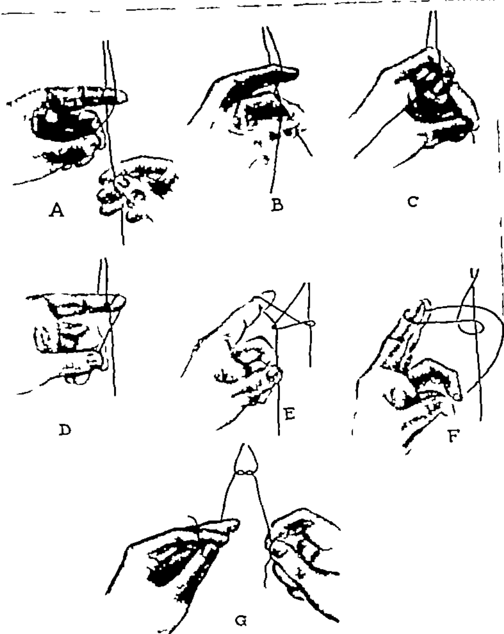


FIG. 3. *Method of Tying One Hand Knot. Part 1.* A. Short end of ligature runs over index finger and is held by middle finger and thumb. B. Short end is pushed under long end. C. Index finger hooks short end. D and E. Short end being pulled through. F End is grasped by index and middle fingers. G Index finger and thumb hold short end as knot is being pulled up Middle finger is placed on top of ligature.

KNOTS AND KNOT TYING

The knot to be recommended for surgery is the square knot, although many world famous surgeons have used instead a granny knot, reinforced by a third knot when the ligature was important. Even when a square knot has been tied, it is a good idea to add a third knot in some situa tions for additional security The surgeon s knot can be used to advantage

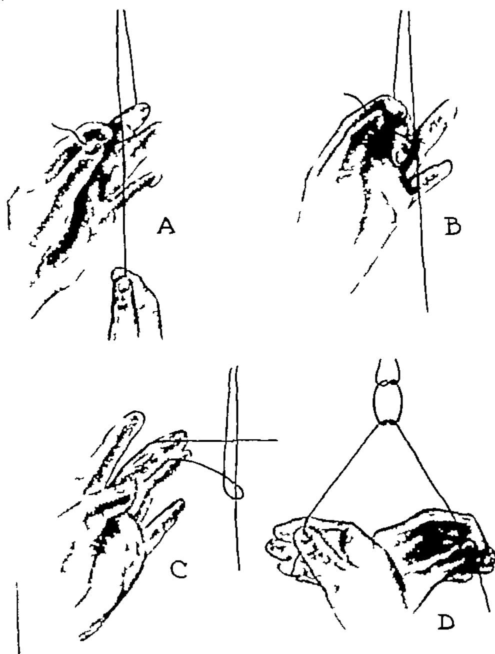


FIG. 4 *Method of Tying One Hand Knot Part* II. A. From last position shown in previous figure, short end runs under middle finger and is held by index finger and thumb B Middle finger hooks over long end to catch short end C. Short end is pulled through by middle and ring fingers. D Knot is pulled tight.

when the first tie must be made under tension, but it has the disadvantage that it is difficult to run the first knot down smoothly to the required tightness and the second knot does not sit well on the first.

For general use, the beginner should perfect a two-hand method of tying knots since it can be used acceptably at all times. The one hand knot, although it has some advantages, is not satisfactory when the knot

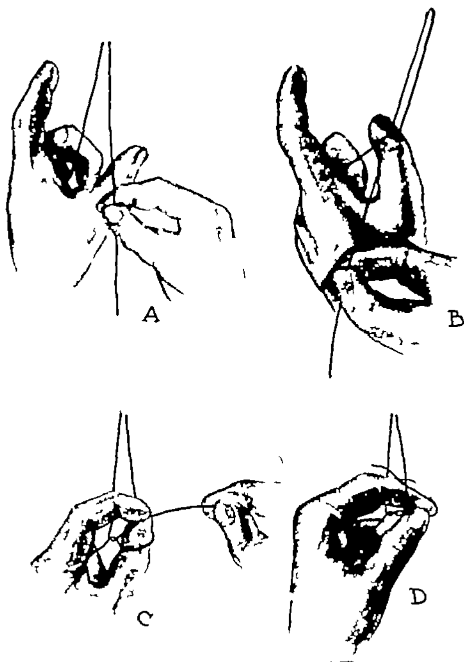


FIG. 5 *Method of Tying Two-Hand Knot. Part* I. A. Long end is grasped in left hand, leaving thumb and index finger free. B Thumb hooks over short end and under long end. C Short end is brought over to end of thumb, and index finger is placed on top of it. D Index finger passes through loop bringing short end with it.

must be tied without placing any tension on the tissue to be ligated, and it is awkward when the end of the suture or ligature is not the right length or when the tie must be made in the depths of the wound. The one-hand knot should be tied with the left hand to leave the right hand free to hold the needle and long end of the suture.

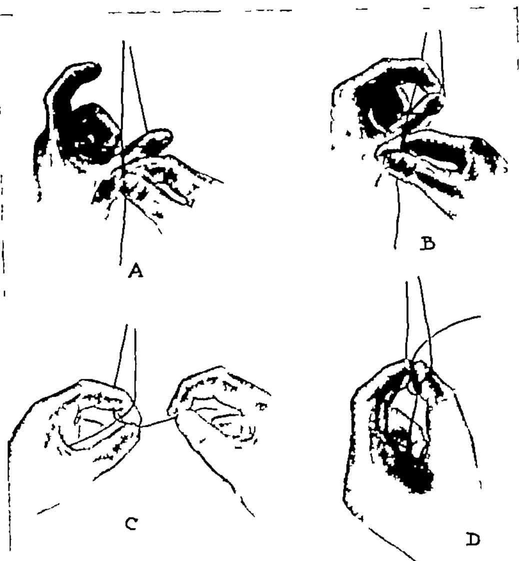


FIG. 6. *Method of Tying Two-Hand Knot Part* II. A. Long end grasped in left hand, leaving index finger and thumb free. Thumb hooks under long end and pushes it under and beyond short end. B Index finger is placed on top of thumb C. Index finger passes through loop and short end is grasped by index finger and thumb D Thumb passes back through loop bringing short end with it.

INSTRUMENTS

The Scalpel

In making an incision the surgeon should grasp the handle of the knife with the dorsum of the hand uppermost and the index finger placed along the back of the blade The surgeon decides exactly where he is to make the incision, and places the index finger and thumb of the left hand so as to straddle the upper part of the proposed incision. The cut is then made with a single assured sweep using the belly of the blade At the beginning and the end of the incision the handle of the knife is lifted sharply

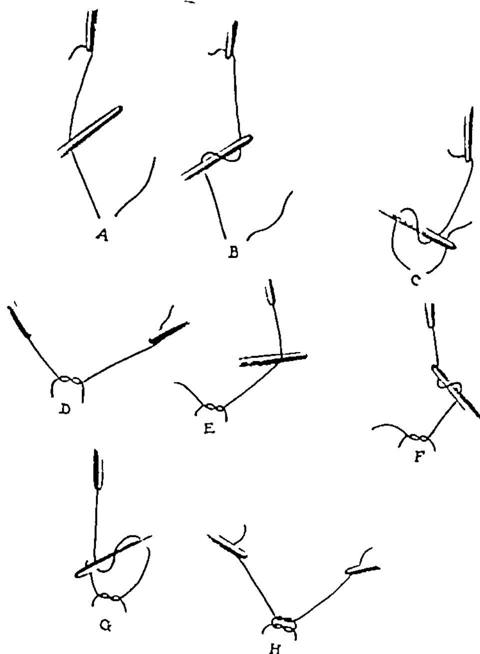


FIG. 7 *Method of Tying Knot with Instruments.* This knot is useful when the ligature has one very short end, but in such a case a granny knot must be tied, since a square knot can be made only by using both ends of the ligature. A While the long end is held, the hemostat is placed on top of it. B The hemostat is turned about the ligature in the direction of the long end C. The short end is pulled through the loop D Knot is tightened. E. Beginning the second knot F The hemostat is passed around ligature with point toward held end. G Ligature is pulled through loop H. Knot is tightened.

so that the wound will be uniformly deep throughout. The blade of the knife should always be as sharp as possible The knife used for making the skin incision should be discarded and not used again until resterilized, because it may be contaminated by the organisms so commonly present in the skin. In subsequent incisions through the deeper layers the index finger is usually removed from the back of the blade, since less pressure is required to cut through these structures. The knife is always held in this manner except occasionally in delicate dissections with the point of the knife, when the grip may be changed to that used on a pencil. The handle of the scalpel makes an excellent instrument for blunt dissection and is often useful as a temporary retractor during an operation.

The Hemostat

There are three types of hemostats in common use each having its place in surgical procedures. For the clamping of skin vessels and for general use, the author s preference is the Ochsner hemostat. This toothed instrument has jaws that are fairly wide at the tip and may be used to grasp a bleeding vessel end on. The pointed hemostat of the Kelly type is so narrow on the end that it must be applied to the vessel with great accuracy in order to stop the bleeding Although it is true that if one applies a hemostat in this manner a smaller amount of tissue will be strangulated by the subsequent tie, in practice there is a great tendency to grasp the vessel not with the point of the instrument but with the point and edge so that the amount of tissue caught by this instrument and the Ochsner is usually about the same The Kelly hemostat, however is superior to the Ochsner in such an operation as a thyroidectomy where one pushes the instrument into the thyroid gland in order to clamp the vessels in its substance. The Ochsner hemostat used for this purpose produces more tearing of the tissues when the two blades are pushed in. In many other situations also the delicate point of the Halsted hemostat has a definite advantage over the more cumbersome Ochsner A curved hemostat of the Pean type has its field of usefulness owing to its angulation and broad clamping surface and in the 8-inch size it is particularly useful for clamping the uterine arteries in performing a hysterectomy

In applying a hemostat, the thumb should be inserted in one ring and the ring finger in the other ring, and when particular accuracy of application is required the index finger may be extended along the instrument to steady it. No more tissue should be grasped in the instrument than is necessary to control the bleeding vessel. The instrument should be closed and locked tightly enough to retain its hold with certainty but should not be locked so tightly as to make its removal difficult. In occasional situations where one must be certain that the hemostat will stay in place and the effort to remove it later is of no consequence, the finger

and thumb may be removed from the rings and the rings pushed together as tightly as they will go by grasping them in the fingers and palm of the hand When two or more hemostats are applied one above the other to a structure such as the renal artery, care should be taken to apply the first hemostat far enough away from the operator so that other hemostats can be applied above it If a hemostat is applied just below one that is already in place, the first one interferes so much with the clamping of the second one that the procedure becomes awkward

Hemostats are usually removed by the assistant while the surgeon ties off the vessel. The method of their removal is an important factor in expediting the operation and assuring the proper ligation of the vessels. The assistant lifts up the first hemostat after the thumb and ring finger have been applied in the rings holds the handle up until the surgeon passes the ligature around it and then depresses the handle so as to bring the point up and allow the ligature to get under the point As the first knot is tightened the hemostat is removed with the right hand, locked to the first notch, and laid on the table. While the instrument is being held up the assistant selects the hemostat attached to the next vessel to be tied and picks it up in his left hand. After the first hemostat has been removed, the assistant transfers his right hand to the rings of the second hemostat, holds it up while the surgeon passes the ligature under it, and then depresses the handle to elevate the point as before. In each case, while a tie is being made the assistant is selecting the next hemostat to be ligated he does this in a systematic order, beginning at one end of the incision and going down the length of the incision, or beginning at the outermost hemostat and going to others deeper in the incision. As a rule hemostats should be tied without twisting them around from the direction in which they were put on, unless one is dealing with a freely movable tissue or pedicle. When the handle of the hemostat points away from the assistant, he reaches over and holds up the handle while the surgeon passes the ligature underneath it. He then lets the hemostat fall and reaching under the arm of the surgeon, grasps the instrument in thumb and finger elevates the point and, as the first knot is tied, releases it. It is easy to learn to snap off a hemostat by grasping one ring between the thumb and the middle finger and pressing the other ring toward the thumb side with the index finger — a method that can be used to advantage many times It should never be used when a large amount of tissue is held in the hemostat or when an important structure is being tied, because the rapid removal of the hemostat may permit the escape of some of the tissue from the ligature. When two hemostats have been applied very close together and are both to be tied off at once the assistant takes a hemostat in each hand and, after the surgeon has passed a ligature around them separates the handles so that the ligature slides down to the points. The hemostats are then

removed almost simultaneously the deeper one first. When a wide pedicle is to be tied it is safer to use a suture ligature, but in any case the hemostat should be removed very slowly to allow the suture a chance to become set in all the tissues. Occasionally it is advisable merely to loosen the hemostat as the first ligature is being applied, and then tighten it again until a second ligature is put on. The first ligature helps to bunch the tissues together so that the second ligature will hold more snugly

The Needle Holder

The most commonly used needle holder is the Hegar type It is advisable to have the holder in two lengths, the 8 inch and the 6 inch. For nearly all general surgery the longer one is used, but occasionally in delicate work it is awkward and it is rather heavy for a small needle The Hegar needle holder may be used with the thumb in one ring and the ring finger in the other but since one so often has to shorten the grip on the holder by running the hand down the handle it is better to put the thumb in one ring and grasp the other ring in the fingers without inserting them into the ring In order to shorten the grip it is then only necessary to remove the thumb from the ring. With practice the needle holder can be opened and closed as easily as when both rings are used.

Tissue Forceps

Thumb forceps with teeth find most general use, but at least one long pair without teeth is necessary for manipulating sponges, etc.

The Scissors

The most popular scissors for general operative work are those of the Mayo pattern. Both curved and straight scissors of this type should be available For cutting sutures, heavy scissors such as those designed by Ferguson are recommended. The thumb should be inserted in one ring of the scissors and the ring or little finger in the other When accurate cutting is necessary the scissors may be steadied by placing the index finger along the shaft. When the cutting has been done, the thumb may be removed from its ring and the scissors held in the palm of the hand with the finger remaining in its ring This leaves the hand free to remove a hemostat or hold a suture taut for the surgeon.

Retractors

There are many excellent retractors made for specific purposes, and only a few will be mentioned here. The broad bladed Fritsch retractor is excellent when a wide retraction of the abdominal wall is desired, as in

cholecystectomy In this operation several sizes of the Deaver retractor are also very useful Murphy retractors are excellent when one is dis secting back a large flap of skin as in a radical amputation of the breast, a thyroidectomy or the repair of a ventral hernia. The double ended U.S Army model retractor also finds many uses and the Balfour retractor is most satisfactory for work in the pelvis. It usually falls to the lot of the second assistant to hold the retractor and it is an important part of the operation. The second assistant usually stands on the same side of the patient as the surgeon in an upper abdominal operation he stands toward the patient's head and in a lower abdominal operation toward the patient's feet To hold a retractor of the Fritsch type he should use the arm adjacent to the surgeon and should grasp the handle so that his elbow will be down thus placing himself as much as possible out of the way of the surgeon. The instrument after being placed in position by the surgeon, should be held by a firm steady pull, without being jerked or allowed to slip It should be removed when the surgeon taps on it or otherwise indicates his desire

Towel Clamps

Clamps of the Backhaus style are commonly used, first to adjust the openings in the draping sheets around the field of operation and hold it in place, and second to fasten towels to the margin of the wound to protect the viscera from contact with the potentially infected skin. There are several methods of fastening the towels to the wound, any of which is satisfactory The author doubles the towel and lays it with the folded edge at the edge of the wound, fastening it in place with three towel clamps, one at each end of the wound and one in the middle. If both prongs of the towel clamp are passed through the towel at its edge and then into the skin, the towel will be held better around the edge of the wound. The clamps should of course be applied so that the handles will fall in a direction away from the incision. When a self retaining retractor is used and it has a tendency to slip out of the edge of the wound, it is useful to apply a towel clamp to the towel just under the edge of the retractor The retractor can then be hooked to skin edge towel, and towel clamp and will hold securely After both towels have been placed, they are covered by moist laparotomy pads arranged around the wound. The Backhaus towel clamp is also useful to grasp the uterus in doing a hysterectomy or to grasp the thyroid gland in a thyroidectomy when no special clamp is available and to hold the edges of an incision temporarily in place until sutures can be put in. When the skin is under tension, as is often the case after a radical amputation of the breast, the latter is a useful maneuver In other cases it gives one an opportunity to test the accuracy with which a wound is being approximated.

Allis Forceps

This is a very useful instrument since if well made, it can be used to grasp the bowel wall without injuring it and in many situations offers a means of holding tissues with less injury than a hemostat would produce.

Intestinal Forceps

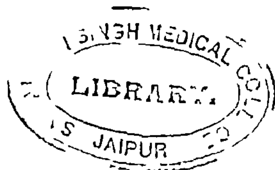
The Doyen model of intestinal forceps is most popular and may be used with or without the rubber tube covering on the blades

The Payr Clamp

This heavy clamp crushes the end of the bowel or stomach and produces an occlusion of the cut end, which persists after the clamp is removed. It is most useful in closure of the duodenal stump or in closure of the colon, but any heavy hemostat may be substituted for it with fairly satisfactory results

Special Instruments

Many operations such as rib resection, trephining, and laminectomy require special instruments but these are mentioned in describing the operation and will not be listed here.



CHAPTER IV

The Skin and Subcutaneous Tissue

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CHAPTER IV

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WOUNDS

Wounds may be classified as clean contaminated, or infected. A clean wound is one that is relatively sterile and contains no particles of foreign matter such as dirt, rust clothing, etc. A contaminated wound is one in which many pathogenic bacteria or particles of foreign matter are present. An infected wound is one in which redness, swelling, or other sign of inflammation has appeared Most surgical wounds are clean wounds and most traumatic wounds are contaminated.

Surgical Wounds

A clean surgical wound should heal by first intention if certain constitutional and local factors do not militate against it. It has been found that hypoproteinemia, lack of vitamin D and malnutrition interfere with primary wound healing and the postoperative care of the patient should be such that these conditions do not appear No incision heals without a scar but it should be the aim of the surgeon to make that scar as inconspicuous and as strong as possible For this primary wound healing is necessary In a clean wound healing begins almost immediately with the collection of fibrin and leukocytes on the opposing wound surfaces and the agglutination of tissue. Soon fibroblasts begin to grow from one wound surface to the other and, closely following these fine capillaries start to make their way across the bridge The delicate tissue thus far formed has little or no strength and the wound can easily be separated by the fingers. After the fourth day however the vascularity becomes lessened, the fibroblasts begin to be replaced by reticular and collagenous fibers, and the strength of the wound increases rapidly until it reaches the maximum about the twelfth postoperative day The surface of the wound becomes epithelized, at first by a single layer of epithelium, which grows in from the skin edges, and gradually the normal stratified epithelium is formed. Fibrosis continues to take place in the scar so that over a period of months it changes in color from red to white

SEBACEOUS AND DERMOID CYSTS

PILONIDAL CYST

TUMORS OF THE SKIN

Benign Tumors

Malignant Tumors

SKIN GRAFTING

The Reverdin Graft

The Thiersch Graft

The Thick Split Skin Graft

The Wolfe Krause Graft

The Pedicle Graft

TRANSPLANTATION OF BONE AND CARTILAGE

EXCISION OF PILONIDAL CYST

The Skin and Subcutaneous Tissue

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There are a number of local conditions that interfere with the orderly process of primary healing described above and cause the wound to heal by the less desirable method of second intention. When, because of loss of tissue, a surgical wound cannot be closed, or when for some reason it is necessary to leave it open the edges of the wound are not in contact and the space between becomes filled with soft granulation tissue. Gradually this granulation tissue is replaced by connective tissue, and epithelization over the surface is a slow process often made slower by projection of the granulation tissue above the level of the surrounding skin. The resulting scar when it finally heals is not only disfiguring but weak and poorly resistant to injury Inaccurate approximation of tissues is sometimes unavoidable but more often it is due to careless suturing, with dead spaces left here and there in the wound. The same effect is produced when, because of inadequate hemostasis, blood clots form in the wound. Mass ligation of vessels and tissue, which leaves large strangulated pieces of tissue to slough off, is another common surgical error Gentle pressure with gauze stops a great deal of oozing and makes ligature of the smaller vessels unnecessary Careful handling of the wound in sponging and in using retractors prevents tissue damage All of these factors, plus the use of an excessive amount of suture material or unnecessary drains predispose to the commonest cause of secondary wound healing, namely infection.

By no means all instances of infection in surgical wounds are the fault of the surgeon, for there are many unavoidable sources of bacterial contamination In spite of the most careful skin preparation, it is impossible to eradicate all bacteria from the skin, and they are also present in the air of the operating room. Bacteria always are a potential source of infection and although in most cases the number that find entrance to the wound or their virulence is not such as to be serious occasionally they gain a foothold and there is evidence of inflammation in the wound a few days later Infection of the wound may take place from within outward, as when a fecal fistula occurs from a cause beyond the control of the surgeon. Inadequate sterilization of instruments and dressings is rarely encountered and, with the present careful control of suture material, infection seldom develops from these causes Unfortunately a very common cause of wound infection is some break in surgical technique to prevent this requires constant watchfulness. Even after the patient has been brought through the operation with a clean wound, infection may take place during convalescence if the wound is improperly cared for or if the dressings become loose or saturated with infective material, such as urine. In summary to obtain primary healing the surgeon should use every precaution to avoid infection, should bring tissues accurately together without interposing dead space, should be meticulous about hemostasis, and should keep sutures and other foreign material to a minimum.

The postoperative care of the wound and treatment of infected wounds are discussed in the chapter on Postoperative Care.

Traumatic Wounds

Any patient who has received a severe wound associated with shock or hemorrhage should receive treatment for these conditions Since this treatment is given in detail elsewhere in this volume (page 9) the treatment of the wound only will be given here.

A very common type of wound particularly in children is the *abrasion* In this there is loss of the superficial layers of the skin usually from friction and capillary oozing may be quite profuse. Such a wound should be thoroughly cleaned with soap and water If there is dirt ground into it that cannot be removed and the wound is in a conspicuous place a general anesthetic should be given and the foreign matter removed by scrubbing with a brush. For the first few days a petrolatum gauze dressing is preferable because it can be removed painlessly but later dry gauze, which predisposes to the formation of a crust on the wound, should be used. This can be left on for a considerable length of time and, if carefully taken off the crust will remain in place and provide the ideal support for epithelization.

A *contusion* is an injury to the skin and deeper structures associated with hemorrhage into the tissues and is usually due to a blow or fall. There may be a great deal of swelling and with the spread of the effused blood the typical "black and blue color of the skin appears This type of wound may require no treatment but moist heat is helpful after a day or two in relieving the pain and promoting absorption of the blood. Occasionally when there is a large amount of blood with fluctuation, it may be advisable to insert a large-caliber needle and draw off some of it. Rest of the part is to be recommended in the early stages since it reduces hemorrhage and lessens pain

A *lacerated* wound, in which the tissues are irregularly torn, and an *incised* wound, which is a smooth cut, receive the same general treatment. When the wound is *superficial* the objectives are the control of hemorrhage, the prevention of infection, the removal of foreign bodies and closure If pressure on the wound is sufficient to control the bleeding, a piece of sterile gauze is held on it if not, a hemostat is applied to the bleeding vessel The skin around the wound is cleaned thoroughly with soap and water and if grease is present ether is used to remove it. Cleansing of the wound itself follows, using soap and water followed by ether if necessary After this, prolonged irrigation with normal saline solution may be employed to wash out foreign particles The skin surrounding the wound is painted with an antiseptic, sterile towels are arranged about the field, and preparations are made for suturing Local anesthesia may be induced with procaine hydrochloride by introducing

the needle through normal skin near the wound. Accurate approximation is made with interrupted sutures of silk or dermal, although small wounds may be closed with strips of flamed adhesive tape. After the application of a sterile dressing, splinting the part will promote healing.

The procedure for treatment of a *deep wound* of the crushed or lacerated variety is essentially the same as that just described. The skin surrounding the wound is cleansed with soap and water and grease is removed with ether The wound itself is thoroughly but gently washed with soap and water and flushed with normal saline, the skin surrounding the wound is painted with an antiseptic, the field is draped off and the condition of the wound is studied. If blood comes from a point deep in, it is best to locate, clamp and tie the vessel, even if in order to do so the wound must be enlarged and deepened. In an emergency pressure applied to a pad of gauze may be sufficient to control bleeding from a small vessel, but if it does not a troublesome hematoma develops and the chance for primary healing of the wound is greatly lessened. Careful hemostasis having been obtained, the edges of the wound are grasped with Allis forceps and approximated. If the skin edges are irregularly torn and the skin of the region is sufficiently loose to permit it, the rough edges are cut off with scissors. If the skin edges cannot be entirely approximated the skin may be undermined for a short distance. This must be done judiciously however since if infection sets in not only is the effort to obtain a good scar wasted but the extent of the wound is increased. If there is a gap caused by avulsion of a portion of the skin and the avulsed skin is available, it may be thoroughly washed with soap and water followed by normal saline solution and sutured in place as a full thickness graft. Such a procedure should be followed only when bleeding is controlled from the subcutaneous tissues and only when a graft would be necessary later

When skin is brought together under tension, it is advisable to use a subcuticular stitch of fine catgut, which will continue to hold the skin edges together after the dermal sutures are removed. When the skin wound is associated with wounds of the deeper structures, severed tendons and veins should be sutured, and then deep tension sutures of silk worm gut may be used to hold the skin together and to obliterate dead space in the underlying tissues In wounds of the face where a perfect scar is most important, such sutures are fortunately unnecessary For suturing the skin fine silk or dermal are most commonly used, and whenever possible the stitches are removed in twenty four hours to avoid the scars left by the sutures themselves. Interrupted sutures are better than continuous since with the former a few sutures can be removed any time without disturbing the continuity of the others

Closure of a wound by primary suture as described above cannot always be done safely One factor that determines whether the wound

should be closed or not is the length of time that has elapsed since the injury From the point of view of time alone, it may be generalized that if the wound is seen less than eight hours after the injury it can be closed with reasonable assurance, but if the wound is over twenty four hours old it can rarely be closed safely Elapsed time is only one element however and equally important if not more so is the nature of the wound Some wounds seen less than eight hours after injury show devitalized tissue are irregularly torn and grossly contaminated It may be impossible to remove all the foreign material and even after debridement closure may not be safe

Debridement, which is done after the wound has been thoroughly cleaned, should include removal of rough skin edges and trimming away of crushed dirty or dead tissues with the frequent flushing out of the wound during the process. After the debridement has been finished the skin is repainted with an antiseptic, and gloves and instruments are changed in preparation for closure

In general, if the blood supply is poor the loss of tissue great, or the debridement incomplete a wound even when seen early should not be closed. It is safer in such cases to pack in a little petrolatum gauze and immobilize the part, with the idea of secondary closure later If the wound looks clean when the gauze is removed after a few days it may be closed loosely with a few interrupted sutures As the use of sulfanilamide in wounds is at present on an uncertain foundation, it is not my practice to use it, although many surgeons do Drainage is not indicated unless hemostasis has not been good or unless there is a dead space that cannot be closed

In wounds seen between eight and twenty four hours, the condition of the tissues, evidence of inflammation, and the amount of foreign material must be taken into consideration in deciding whether to close the wound or not. Debridement should not be done on wounds seen later than eight hours after injury except in cases where the general condition of the wound is unusually favorable.

Tetanus antitoxin or toxoid as indicated should be given to patients with a contaminated wound unless it is of the most superficial variety If secondary closure is done longer than ten days after the first procedure, the dose should be repeated In severe wounds 1500 units of tetanus antitoxin is not large enough to be relied on. A better dose is 50 000 units. Following the operation, sulfonamides or penicillin is administered whenever the injury has been severe

Puncture wounds and *penetrating* wounds require special consideration because here the skin opening is small and the tract of damage may be deep As a rule, the point of entrance and of exit should be cleaned and the part treated by immobilization. If a foreign body is present a short distance below the skin, it may be possible to grasp and remove it.

No attempt should be made to sterilize the tract and as a rule it is not wise to search for small metallic objects, such as bullets. When foreign material such as clothing, is driven into the wound, wide incision with excision of the tract and removal of the foreign material may be necessary It is in these wounds that tetanus is most apt to develop

When *infection* has developed in the wound, treatment should consist of moist hot dressings and penicillin or sulfonamide therapy Early local treatment should be confined to cutting sutures if they are present and the tension produced by the swelling is producing damage. If suppuration takes place the prime consideration is proper drainage and the removal of foreign matter If foreign bodies of any size are known to be present in the wound they should be removed, enlarging the wound if necessary to reach them. Small particles of foreign matter should be washed out by squirting in normal saline solution under gentle pressure. A subcutaneous abscess should be explored and all communicating pockets converted into one cavity Soft rubber drains are inserted and the wound should be left open. Later it may be irrigated with Dakin s solution. As the infection subsides the skin edges can be gradually pulled together by adhesive plaster strips so that the raw granulating surface will be as small in area as possible.

GANGRENE OF THE SKIN

Gas Gangrene

Gas gangrene of the skin is seen in association with infection of the deeper tissues Arising usually from a deep lacerated wound and associated especially often with compound fractures, the main site of the disease is in the muscles The part becomes swollen, edematous and tender and the skin becomes at first red and then brownish. In the muscles, crepitation can be felt and may be apparent even when a finger is laid gently on the skin to press it inward. Brownish seropurulent fluid exudes from the wound and gas bubbles may be seen in it. The muscles become soft and brownish, differing distinctly in color from the normal muscle. The infection may spread along a muscle or a group of muscles, but eventually it works its way throughout the extremity There is frequently a characteristic musty smell to the infected tissues.

In the treatment of the condition, all devitalized tissue and foreign bodies should be widely removed and free drainage instituted. Gas gangrene antiserum should be given intravenously and repeated every four hours, and roentgen therapy should be given over the infected area. Massive doses of penicillin have been given with some favorable results. If treatment of the disease is begun early amputation may be postponed for a time to await favorable response to the foregoing treatment.

Gangrene due to Hemolytic Streptococcus

This begins usually on an extremity following a wound that in itself may apparently be slight It is characterized by a spreading area of erythema, which after the third or fourth day begins to show a purplish color in some parts of the reddened area Bullae or vesicles appear and the dark region of skin becomes definitely necrotic, with sharply demarcated borders Streptococcus infection may develop secondarily in the lungs, subcutaneous tissues or elsewhere in the body Surgical treatment should be instituted at once and longitudinal incisions should be made from the normal skin across the involved area to the normal skin on the other side to relieve tension and promote drainage Hot wet dressings should be applied and penicillin should be given in large doses The slough should be removed as fast as it separates a portion each day until bleeding is encountered Sulfonamide therapy is also of value

Postoperative Gangrene

Following the drainage of an abscess usually in the pleural or peritoneal cavity *tenderness in the region of the wound may develop* The wound becomes red and edematous and later in the center of the reddened indurated area purplish spots appear which soon enlarge and become dark brown and obviously gangrenous. The process spreads peripherally the reddened outer zone being raised above the normal skin and the gangrenous portion sloughing off leaving a necrotic base. The infection is due to a mixed infection with a non hemolytic streptococcus and a hemolytic staphylococcus aureus The treatment consists of radical removal of the entire reddened gangrenous area by excision. After the lesion has healed, skin grafts may be applied. Penicillin has recently been found to be effective in some cases and operation thus avoided.

Gangrene Following Bites

A type of chronic gangrene may develop following human bites or contamination of a wound with saliva. There is first the usual evidence of inflammation, but swelling soon becomes excessive and induration extreme. There is a *foul discharge and the edges of the wound begin to* appear necrotic. Infection spreads from the wound into the surrounding tissues, and by penetration to the surface in another area sinuses are formed. After weeks of infection there is extensive destruction of the skin and subcutaneous tissues although the typical dark color of gangrene may be seen only at the wound margins. In the treatment of the wound, drainage should be established when necessary and zinc peroxide, as advocated by Meleney [1] may be mixed into a thick suspension in water

1. Meleney F L.: Important Anaerobic Infections and Use of Zinc Peroxide in Their Control, *U S Nav. M Bull.* 40 479 1942.

and impregnated into gauze, which is insinuated into the wound. The whole is covered with absorbent cotton similarly treated with the zinc-peroxide suspension, and this in turn is covered with vaseline gauze.

Amebic Gangrene

Gangrenous infection of the skin due to amebic and bacterial mixed infection has been reported. It may follow operation for amebic abscess of the liver Emetin hydrochloride should be given intravenously and zinc peroxide may be used locally by the method described above.

Gangrenous Impetigo

This is an infectious type of gangrene of the skin that occurs in elderly or debilitated people. Vesicles appear which rapidly become pustular and then gangrenous. The lesions are multiple and tend to coalesce crusts form and the necrotic skin sloughs off leaving small rounded ulcers which slowly heal The infection is thought to be due to a streptococcus and staphylococcus working symbiotically Treatment is directed largely to improving the patient s general condition, but complete excision of the lesions is advocated. Sulfonamides or penicillin should also be given.

INDOLENT ULCERS

Arteriosclerotic Ulcer

This type of ulcer occurs most commonly in diabetics and is a localized and usually sharply demarcated area of necrosis in the skin. It may be located in any part of an extremity Secondary infection may take place with suppuration, and the process invades deeper structures with necrosis of muscles and tendons.

Decubitus Ulcer

Bed sores frequently occur in patients who are chronically ill. Redness of the skin appears first and then with continued pressure there is sloughing and secondary infection. Such ulcers are usually located over bony prominences that sustain the patient s weight.

Trophic Ulcer

With loss of the sensory nerve supply the anesthetic area becomes very susceptible to injury Infection once established tends to progress with localized necrosis

Varicose Ulcer

Associated with varicose veins and poor circulation to an extremity large ulcerated areas are often seen usually on the anterior and inner aspect of the leg

Radiodermatitis

Exposure to X ray or radium may produce necrosis of the skin with a sluggish ulcer Malignant degeneration in these ulcers is common.

Treatment of Indolent Ulcers

Exciting or predisposing causes, such as diabetes, malnutrition anemia, avitaminosis, and poor circulation should be treated The patient should receive a well balanced diet with supplementary vitamins the diabetes should be controlled, and when poor circulation is a factor elevation of the part will reduce edema and hasten healing Varicose ulcers should receive local heat and frequent cleansing and support by means of an elastic bandage and bed rest should be instituted. Varicose veins should be treated by ligation and injection after any acute inflammation in the ulcer has subsided. In decubitus ulcer pressure over the ulcer should be relieved by a special mattress rubber rings and frequent changes of position are important. Many patients feel most comfortable lying in the position they were in when the ulcer developed, and it may require almost continuous attention to keep the patient turned Often a deep ulcer can be cured by wide excision down to the normal tissue, followed immediately by a skin graft.

Marjolin s Ulcer

Epidermoid carcinoma may develop in any indolent ulcer One portion of the periphery of the ulcer appears to become thickened and rolled, and the process gradually extends along the margin and in toward the center Removal of a piece of tissue from this region shows typical carcinoma. If possible, the entire ulcer should be radically removed along with the underlying tissues, and the defect covered by a skin graft. If the lesion is too extensive to permit this amputation of the extremity with dissection of the regional lymph nodes must be done, since the lesions are radio resistant.

FURUNCLE

A boil should be treated by the application of hot wet dressings until pus has formed, when a linear or cruciate incision can be made in the apex for drainage. If the boil is located on the face particularly above the angle of the mouth, penicillin or sulfonamides should be given, but no incision made Hot compresses should be continued until the boil opens spontaneously Although this means that relief must be delayed, the communication between the cavernous sinus and the anterior facial vein makes a spreading infection that might be caused by incision extremely dangerous.

CARBUNCLE

Hot wet dressings should be used locally and sulfonamide or penicillin therapy should be instituted. When pus has formed, a cruciate incision should be made and the four flaps undermined to the edge of the lesion. Gauze is packed loosely under the flaps to hold them up until sloughing is completed, when they are allowed to drop back into place.

BURNS

Burns of the skin are commonly classified as first, second, or third degree In the first-degree burn there is a simple erythema of the skin, in the second-degree burn vesicles are formed, and in the third degree there is destruction down to and including the papillary layer of the derma. In a third-degree burn the skin appears blanched or charred and vesicles are not often seen, but the degree of the burn may be impossible to determine until separation of the slough takes place. Partly because of the destruction of the nerve endings in the skin and partly because of shock, the patient with extensive third-degree burns may not suffer a great deal of pain and the burned parts may show little or no tenderness Recently I had a woman patient who sustained very extensive burns in the explosion of a gasoline truck. After her admission to the hospital I saw her hold up and examine her hands and forearms, moving the fingers wrists and arms and looking at them almost impersonally although the burned skin was hanging from them in ribbons and she was to die four hours later The patient, at this time, was in a state of primary shock due to the magnitude of the injury but secondary shock, the much more serious condition, soon set in in spite of treatment.

With any extensive burn, whether it is a second or third degree, there is loss of plasma volume due to edema and fluid loss from the burned area. The loss of fluid begins immediately and is proportional to the per cent of body surface burned. Loss of plasma volume is greatest during the first twenty four hours and after that time begins gradually to decrease The edema begins to be absorbed after forty-eight hours. With loss of plasma the blood becomes thicker the circulation slower and blood pressure reduced. Shock may be present within two hours if proper measures are not taken to combat it. Any burn that covers more than 10 per cent of the body surface is potentially dangerous and hematocrit determinations should be made frequently For each per cent above 45 in the hematocrit reading, 100 cc. of plasma should be administered. This should be repeated as often as necessary to reduce the reading For the replacement of plasma volume plasma is the best fluid, but if it is not available whole blood may be used, or gelatin as a third choice Normal saline should also be liberally supplied by intravenous injection daily to maintain normal chloride levels.

An important cause of death in the severely burned patient is secondary shock, and if the patient's life is to be saved treatment must be directed toward combatting this condition. The patient on admission to the hospital should not be sent to the operating room to have the wounds cleaned but should be placed immediately in bed. He should not be left uncovered because of fear of infecting the burned surfaces but should be covered by sheets and blankets, with hot water bottles distributed around him to keep up the body temperature After a quick inspection of the degree and the extent of the burns preparation should be made for simultaneous treatment directed toward the prevention of shock and the care of the burned areas. Morphine is given as indicated for pain, and gross contamination is removed by washing with a stream of water The extent to which one should go with this cleaning process is determined by the extent of the burn and the general condition of the patient. The object of cleaning the wound is to prevent infection but it is foolhardy to subject a patient the major portion of whose skin is burned and who is in imminent danger of death, to rigorous and long continued wound treatment when common sense dictates that he be disturbed as little as possible When the burn is less extensive cleaning can be thorough and should begin with the skin surrounding the burn Then, using cotton balls and liquid soap the burned surface itself can be similarly treated The wash water from the surrounding skin should not be permitted to run over the burn.

In regard to the type of treatment to be used on the burned area, my experience has not made me so enthusiastic about any one method as to condemn all others For burns on the trunk I have been in the habit of using triple dye and for burns of the extremity and head, petrolatum gauze and a pressure dressing. The triple-dye method should not be used on burns of the hands or face or on encircling burns of the forearm or leg, because of the possibility that shrinkage of the tanned surface may cause interference with the blood supply or contracture Gentian violet alone may be used instead of the triple dye with comparable results Tannic acid also has an escharotic effect and is applied in the same way as the dye, but is being gradually discarded because of occasional toxic effects. The composition of the triple dye is as follows

Crystal violet	1.5
Brilliant green	1.00
Neutral acriflavine	0 75

97.5 gm. of this mixture is dissolved in 3000 cc. of sterile water before use.

Gentian violet is applied as a 1 per cent solution and tannic acid in 5 to 20 per cent strength.

Recently the pyruvic acid method has been introduced and has the advantage of shortening the period of hospitalization.

Petrolatum Gauze and Pressure Dressings

Blisters are not opened and the whole area is covered with gauze impregnated with sterile petrolatum. This is covered with dry gauze and on top of this a thick layer of mechanic s waste the whole being held in place by an elastic bandage In applying the bandage one should start peripherally and work centrally The bandage should be applied snugly but not tight enough to obstruct the circulation. Dressings should not be changed any oftener than necessary the first one usually being left on at least a week and preferably two weeks

Triple Dye Treatment

The wound is cleaned only if there is gross contamination. Blisters are opened by cutting off a portion of the top of each with scissors and spraying the triple-dye solution on the burned area with an atomizer or lightly painting it on with a sponge. As soon as one coat has dried, an other is applied, until there is a protective crust over the burn. No dressings are necessary but the burned portion of the body should be enclosed in a tent in which an electric lamp keeps the air warm and dry At the end of about two weeks the crust begins to separate. Its removal may be hastened if necessary by applying continuous moist dressings of sterile water If infection takes place beneath the tanned surface the membrane should be fenestrated or removed over the infected area. Areas of infection can be detected by the softening of the crust in that region and its separation from the burned surface After the membrane has been entirely removed, the granulating surface may be treated by applying a petrolatum dressing or it may be allowed to remain open under the tent until healthy granulations are present and infection is at a minimum.

Pyruvic Acid Method

Based on the theory that a lowered P_H hastens the separation of the slough, Connor and Harvey[2] have developed a method of treatment by which pyruvic acid is kept in contact with the burned surface for prolonged periods. Pyruvic acid is placed in a cornstarch medium and the moist paste is placed in contact with the burn as soon as shock symptoms if present, have been relieved. The paste is renewed at intervals until the burned area is ready to receive a graft. The treatment, which is most useful for deep burns but which can be used on any burn in which a graft may be necessary provides the quickest method of obtaining clean granulations and may be used in any case when removal of

2. Connor G. J., and Harvey S C.: The Pyruvic Acid Method in Deep Clinical Burns, *Ann. Surg* 124 799 1946.

the slough is desired regardless of the type of treatment that had previously been given

The pyruvic acid paste is prepared by first making a solution of 7 cc. of pyruvic acid in 1 liter of distilled water The P_H of this solution should be 1.9 To 200 cc. of this solution 10 per cent of cornstarch is added The remaining 800 cc. are heated almost to boiling and then poured into the starch mixture while it is constantly being stirred Continued stirring produces a thick smooth paste which thickens still more after being placed in an ice bath for cooling To make smaller or larger amounts of paste the same method and percentage of ingredients are used.

Preliminary debridement or cleaning of the wound is not necessary unless there is gross contamination, and blisters need not be opened unless there is tissue under them that must slough. When a heavy slough is present it is advisable to cross hatch it since the pyruvic acid works from the edge of the slough and the more edges present, the more effective it will be The paste is applied thickly on the wound, where it is held in place by a gauze dressing. To prevent drying vaseline gauze is applied over the dry gauze Thick gauze is applied over the vaseline gauze and the whole is held in place by an elastic bandage. If there is danger of contracture and this is true regardless of the type of treatment used, splints should be incorporated in the dressing As the application of the pyruvic acid-starch paste may cause pain a narcotic should be given about half an hour before the dressing is applied, unless the nerve endings are so deadened as to make this unnecessary The dressing should be changed in two or three days and any paste remaining on the wound should be wiped away so that the wound can be inspected In the first dressing of a fresh burn, little separation of the slough will be noted but if the burn is older definite development of a cleavage plane between the slough and the granulation tissue will be seen Another pyruvic-acid dressing is applied and this again is left on for about three days At the end of a week the slough should be fairly well separated, especially if the surgeon aids the process by snipping with scissors the little fibrous bands that hold the slough down and that will be seen when the edge is lifted up When the area to be treated is a uniform deep burn with no islands of epithelium that must be preserved, the strength of the pyruvic acid solution may be increased to 9 cc. per liter and the separation of the slough will be accelerated.

Prevention of Infection

All burns are potentially infected, since even though the flame or heat may sterilize the skin, the clothing and surroundings the patient touches are infected Sulfonamide or penicillin therapy should be used for all except minor burns Neither of these is to be applied locally except in the case of small burns when sulfonamide ointment may be used. Infec-

tion developing under a slough should be drained by incising or removing the slough.

Skin Grafting in the Treatment of Burns

Skin grafting should be done as soon as possible since it is the most effective means of shortening convalescence and preventing scars and contractures The two requirements that must be met before a wound can be grafted are freedom from slough and minimal infection. Spontaneous sloughing of dead tissue takes from two weeks to a month, but it can be hastened by surgery or by pyruvic-acid dressings. In surgical debridement a general anesthetic is necessary All dead tissue is removed down to a freshly bleeding surface and after control of the hemorrhage a thick split graft is put in place Debridement by means of pyruvic acid takes more time to accomplish than surgical debridement, but it has the advantage that no blood is lost and no anesthetic is necessary except to remove the graft. All third-degree burns should be grafted and some deep second-degree burns are preferably grafted. A third-degree burn of limited extent should be grafted immediately The dead skin is excised with a knife and a graft is removed from another part of the body and sutured in place For this purpose the split graft removed with Padgett's dermatome is most satisfactory The use of skin grafts is necessarily limited to the amount of skin available for grafting It must be remembered that a surface from which the graft is removed provides another raw area, and for one who has already sustained the loss of considerable skin surface this may be very serious. Even with the patient in the best of condition with relatively small burned surfaces, no more than three drums should be cut at one time with larger burns one drum may be all that the patient can stand.

Nutritional Disorders and Anemia

With any severe burn it may be a problem to keep up the patient's nutrition. With the increased metabolic rate due to fever the carbohydrate supply is likely to be inadequate but the loss of protein may be more important. The patient may find a high protein diet difficult to take because of poor appetite, and it should be reinforced by protein digests given orally or intravenously Vitamin requirements should be satisfied to promote the healing processes With any large burn, the patient tends to become progressively anemic, and not only should iron and an adequate diet be supplied but transfusions of whole blood should be given freely

SEBACEOUS AND DERMOID CYSTS

Sebaceous cysts, which are due to obstruction of the duct of a sebaceous gland and dilatation of the gland, are most commonly seen on the

scalp, neck, and face. They produce a rounded swelling and grow very slowly producing no symptoms unless they become infected

Dermoid cysts which develop from skin rudiments may be found not only under the skin but in various other locations in the body Such cysts arising in the ovary are common and other frequent locations are the sublingual or submental regions.

Malignant degeneration of a sebaceous or dermoid cyst is rare but demands excision with wide removal of the surrounding tissue.

PILONIDAL CYST

This is a cyst of congenital origin located in the midline near the level of the lower end of the sacrum. A dimple is usually present in the skin over the cyst and not infrequently the cyst ruptures to the outside to form a fistula, which may become secondarily infected. The cyst itself may or may not be palpable under the skin. The proper treatment of the condition is complete excision of the fistulous tract and the cyst. To assure this it is necessary to excise a rather wide section of skin and tissues down to the fascia covering the sacrum. Before the operation is begun, methylene-blue solution may be injected to help in outlining the tract. There is considerable difference of opinion on the method of dealing with the wound. The ideal treatment is complete closure of the wound by suture after undermining flaps on both sides, but in the author's opinion it is wiser to leave the wound open and pack it daily with gauze.

TUMORS OF THE SKIN

Benign Tumors

Common benign tumors of the skin and subcutaneous tissues are fibroma, hemangioma, papilloma, neuroma, nevus and lipoma. Keloid and senile keratosis, while not true tumors may also be mentioned here Most benign tumors require no treatment, but they may be surgically excised if they are subject to repeated trauma, have an objectionable appearance, or cause pain. Treatment of the cavernous type of hemangioma is very unsatisfactory by any method, but the more superficial angioma can often be controlled by radiotherapy or carbon-dioxide freezing A blue-black pigmented mole, unless it is in a location where it is subjected to repeated trauma, should be left severely alone, but if it is necessary to excise it the incision should extend well into normal tissue because of the danger of transforming the tumor into a melanocarcinoma. The treatment of keloid is also very unsatisfactory and if the mass is excised it will most certainly recur Radiotherapy has been used without much success.

Malignant Tumors

Two types of malignant neoplasms of the skin are often seen, basal-cell carcinoma and epidermoid carcinoma. Melanocarcinoma is fortunately comparatively rare and sarcoma of the skin most uncommon.

Basal-cell carcinoma or rodent ulcer is often seen, usually in elderly people. It may appear any place on the body, but is most often encountered on the forehead or cheek above the angle of the mouth. It begins as a small slowly growing nodule, which ulcerates to leave a flat truncated cone The edges of the ulcer crater are raised and rolled and the ulcer is commonly covered with a thick crust. The lesion slowly increases in size and may cause extensive destruction of tissue, including bone and cartilage Metastasis does not occur unless the lesion should undergo transition to a squamous-cell carcinoma. The treatment is wide excision of the lesion, but in locations where this is not practical radiotherapy may be used.

Epidermoid carcinoma is most often seen on the lip on the lower more often than the upper but it may occur on any part of the body It begins like basal-cell carcinoma as a raised nodule that soon ulcerates, becomes covered with a crust, and develops a wide indurated margin. In many cases it cannot be distinguished from basal-cell carcinoma by its gross appearance, but a location below the angle of the mouth is suggestive of epidermoid carcinoma. Metastasis takes place to the regional lymph glands Treatment may be wide excision of the lesion and the regional nodes or excision of the lesion and radiotherapy to the nodes, or radiotherapy to both lesion and nodes.

Melanocarcinoma, one of the most malignant tumors known, may develop from a blue-black mole without any exciting cause or as a result of repeated trauma or insufficiently wide removal of the mole. The *malignant tumor like the mole is bluish-black in color but grows* rapidly and has a tendency to produce multiple satellite metastatic tumors of the skin. It metastasizes also to the regional glands and by way of the blood stream. Melanocarcinoma should be very widely excised and the regional glands should be dissected out. If metastasis has occurred, however the prognosis in spite of surgery is practically hopeless

Sarcoma of the skin may be secondary to a primary tumor elsewhere but primary sarcoma is occasionally encountered. The tumor may occur on any part of the body begins as a smooth, rounded, or lobulated mass grows rather rapidly and may ulcerate Wide surgical excision of the lesion is indicated.

SKIN GRAFTING

If a defect in the skin exists and cannot be closed by one of the simple plastic procedures illustrated (Figure 8), skin grafting may be neces-

sary Of the several kinds of grafts the most suitable type should be chosen The skin to be grafted should be obtained from some part of the patient s body where the scar left by the removal of the graft will be inconspicuous and, particularly when thick grafts are used, the char acter and color of the skin matches the recipient site. Hair-bearing skin

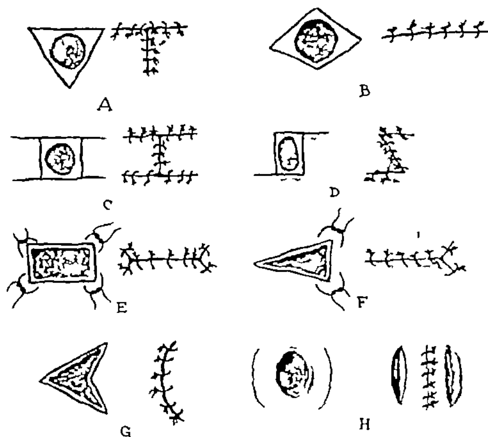


FIG. 8 *Methods of Closing Skin Defects*

may be obtained if desired from the axilla, pubis or scalp Hairless skin, which is useful in repairing an eyelid, for instance may be obtained from the prepuce or the inner surface of the arm.

The area to be grafted should be covered with healthy pink granula tion tissue, or it should be an uninfected surface recently denuded by surgery There must be no oozing of blood, since it collects under the graft and interferes with its attachment. If the granulation tissue is exu berant, it should be painted with 5 per cent silver nitrate solution once or twice a day until the desired level is reached. Infection with the dis charge of pus interferes with a successful take and must be treated before skin grafting is undertaken.

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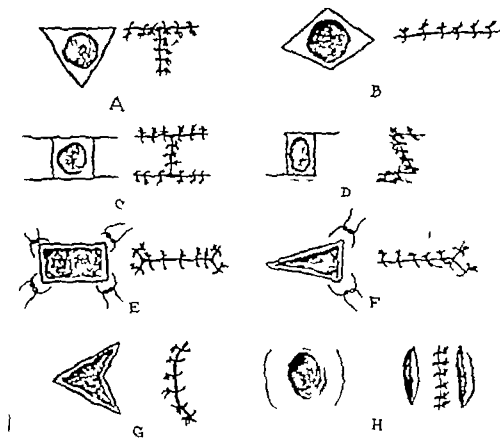


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The Reverdin Graft

This graft and the small deep graft, both known as pinch grafts are the simplest, most easily performed, and most successful types of graft. A straight intestinal needle held in a hemostat is inserted into the skin (Figure 9A) and, while a cone of skin is lifted up part of the cone is cut off with a razor blade. If the apex of the cone only is excised it is called a Reverdin graft if the cone is cut off at its base, the full depth of the skin is often removed, and it is called a small deep graft (Fig

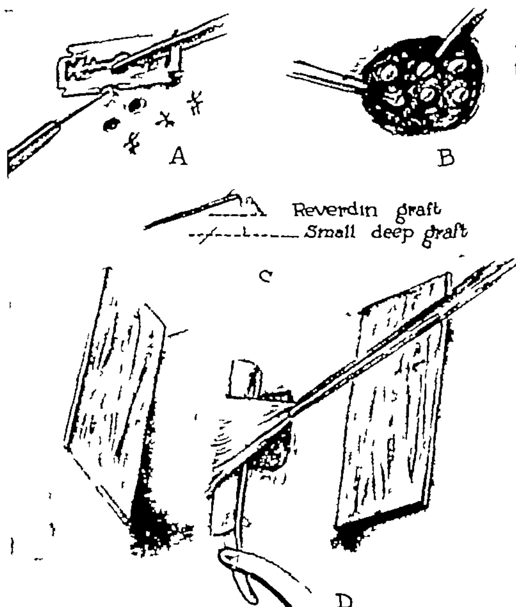


FIG. 9 *Skin Grafting* A Method of cutting Reverdin graft and small deep graft B Placing the grafts on the granulating area. C. Relative amount of skin removed for Reverdin graft and small deep graft. D Method of cutting Thiersch graft and thick split skin graft.

ure 9C) The cone of skin impaled on the needle is transferred to the site to be grafted and set down on the granulating surface (Figure 9B) where it is adjusted with another needle. Such grafts are about .5 cm. or less in diameter and any number of them may be removed from a given site as long as a small area of normal skin is left between the pits The grafts should be placed 1 cm. or less apart and covered with paraffin impregnated gauze or vaseline gauze pressure being made on this sufficient to flatten out the grafts and hold them in place. A bandage is applied and the dressing should not be changed sooner than forty-eight hours and then only if the discharge from the wound makes it necessary The application of these grafts to the wound not only partly covers the wound with skin but stimulates the growth of epithelium from the edges of the wound. A single stitch may be used to close each of the wounds at the donor site, to minimize scarring The disadvantages of the Reverdin and small deep grafts are that when healing is complete the surface is unsightly with spotted raised areas where the grafts were implanted, the wound has a tendency to contract and the row of scars at the donor site are somewhat conspicuous. The advantages are that the donor site can be placed in an area covered by clothing no treatment of it is necessary except the usual protective dressing and the entire procedure is technically so simple and effective. When the grafted area is to be covered by clothing and when contracture of a moderate degree is not important, the method is thoroughly satisfactory

The Thiersch Graft

This graft consists of a relatively large sheet of tissue paper thin skin, which includes the epithelial layer and the upper part of the corium. It is a useful method of covering large raw surfaces, and gives a good cosmetic effect. The healed surface however is somewhat easily injured and the skin tends to be somewhat fixed and not freely movable Thiersch grafts are usually obtained from the thigh after surgical preparation of the skin. The skin is stretched taut between two flat edges such as splint boards (Figure 9D) and, using a razor a piece of skin of the thickness of tissue paper and the width of the razor blade is cut off by a sawing motion. The razor is kept moist with normal saline solution during the cutting The graft is picked up with forceps and laid, raw surface down, on the surface to be grafted. If one graft is not sufficient to cover the area, two or more additional grafts are applied. Overlapping of the graft does no harm except that the portion that overlaps will die and slough off A paraffin gauze or vaseline gauze dressing is applied and bound in place. If necessary to avoid motion, the grafted region is splinted. This dressing should be left in place for five or six days. A vaseline gauze dressing should be applied to the donor site.

The Thick Split Skin Graft

This graft is similar to the Thiersch graft except that one-half or three-fourths of the full thickness of the skin is sliced off The graft, like a Thiersch graft, is usually obtained from the thigh, but the abdomen, arm, buttocks, chest, and less commonly the back may also be used. The skin surface provided by this type of graft is more stable than that provided by the Thiersch graft. The donor site heals well but is a little more conspicuous The graft may be cut with a razor by the same method as the Thiersch graft. Padgett[3] has devised an ingenious dermatome for cutting grafts of various intermediate thicknesses and for one who does considerable skin grafting the instrument is a great convenience. Uniform sheets of skin 10 by 20 cm. in area may be cut with it very easily Thick split skin grafts should be sutured in place with an interrupted or continuous suture of silk, if several grafts are used they should be anchored in place by suturing the edge of the graft to the granulating surface by a few interrupted stitches No systemic symptoms are produced by the removal of moderate-sized areas of skin, but no more than three times the area of the drum should be removed at one time.

The Wolfe Krause Graft

The full thickness graft gives the most satisfactory cosmetic result of all, although even here the site of the graft may be noticeable because of a difference in pigmentation between it and the surrounding skin. Since the donor site is completely denuded of skin, unless the edges of the skin can be brought together by undercutting, the site must often be grafted with Thiersch or Reverdin grafts. After proper preparation of the bed to be grafted, which means the excision of scar tissue down to a healthy level base with a good blood supply a pattern of the defect is cut out of tinfoil or rubber tissue, is laid on the donor site and its outline marked. With a sharp knife an incision is made straight down through the full thickness of the skin, the edge of the skin is grasped and pulled up and the skin in the desired pattern is dissected up in such a way as to leave the subcutaneous fat behind (Figure 10A) The under surface of the skin should have a pitted appearance. The graft is lifted up with forceps placed in position, and sutured in place, using interrupted or running stitches of silk (Figure 10B) If the graft is over 3 cm. square small perforating incisions should be made in it to permit the escape of accumulated serum. A pressure dressing of mechanic's waste should be applied, and if necessary to avoid motion the part should be splinted.

3. Padgett, E. C.: 'Calibrated Intermediate Skin Grafts, *S G and O* 69 779 1939

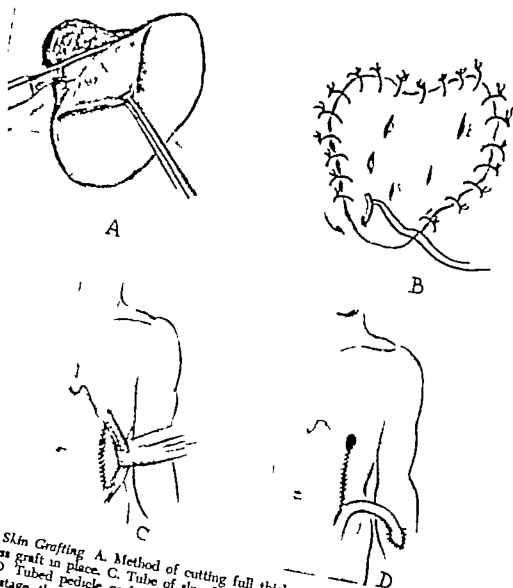


FIG 10 *Skin Grafting* A. Method of cutting full thickness graft B Suturing full thickness graft in place. C. Tube of skin for tubed pedicle graft raised from abdomen D Tubed pedicle graft released at one end and sutured to forearm. In the next stage the other end of the tube will be released and transplanted to the defect by raising the arm to the appropriate position.

The Pedicle Graft

In many cases when a full thickness skin graft is necessary and when it is desirable also to transplant some of the subcutaneous tissue, the pedicle graft is the most satisfactory and certain method to use Subcutaneous fat alone can be transplanted, but there is considerable shrinkage and it is difficult to obtain even distribution.

In the simple pedicle graft, a flap of skin and as much fat as desired is dissected up and a portion of the raw surface is sutured to the defect to be covered, either by twisting the flap or by bringing the part with

the skin defect to the neighborhood of the flap Thus to cover a defect on the nose a flap of the appropriate shape is raised on the forehead, its pedicle twisted as necessary to bring it over the nose and the flap is sutured in place over the defect. When the graft has taken in its new location, the pedicle is severed and the unused portion is returned to the forehead, where it is sutured in place. If it is desired to cover a granulating surface on the arm, a flap is raised on the abdomen and the arm brought across the abdomen so that the flap of skin can be sutured over the defect. The arm is held in place by bandages, or a plaster cast if necessary, until the graft has taken, after which the pedicle is cut and the unused portion returned to the abdomen. The abdominal defect can be closed by undermining the skin and bringing the edges together but when a flap is raised in some locations it may be necessary to cover its bed with a free skin graft. Grafts may be transferred by the flap method from one leg to the other from the arm to the body or vice versa, and from the arm to the neck and face and so on

A useful procedure when there is extensive destruction of the skin on the dorsal surface of the hand is to make a pocket under the skin of the abdominal wall, place the hand in it with the dorsal surface outward, and make small incisions at the appropriate level to allow the ends of the fingers to protrude The hand is held in this position by the application of bandages and adhesive tape until the skin has grown to the back of the hand, usually about ten days. The skin is then cut around the hand, the hand is removed, and the defect in the abdominal wall is closed by undermining the skin. When the lesion is on the palmar surface the hand may be placed in a similar pocket on the hip

When the skin flap is long in proportion to the width of its pedicle the delayed method of transferring the flap is used The flap is outlined, raised from its bed, and then sutured back in place At the end of a week or ten days the blood supply has increased through the pedicle and the flap may be relifted and sutured to the defect with assurance that it will survive It is not advisable in any case to have the flap more than three times as long as the width of the pedicle

A very useful modification of the pedicle graft is the tube graft. Parallel incisions about 7 cm. apart are made at the donor site, and the skin between the incisions is raised up so that it is attached only at its two ends (Figure 10C) The raw surface is turned inward and the skin is sutured so that a tube is formed attached at its two ends like the handle of a suitcase The region from which the skin was raised is undermined and the skin is sutured together under the tube The tube is left in this position for at least two weeks and at the end of this time one end of the tube is cut loose. If this end of the tube will reach the region to be grafted it is sutured there After sufficient blood supply has developed at the new site the needed portion of the tube is cut off the tube is

opened up and sutured in place, and the unused portion of the tube is opened up and returned to the donor site if it is required there When the tube is not long enough to reach the place to be grafted one end of it may be first transferred to an intermediate point by a process known as caterpillaring (Figure 10D) When blood supply has developed from the new site the tube is severed from its first attachment and transferred to its final location Thus a tube flap may be raised on the abdomen, one end of it transferred first to the arm, and then the other end transferred to almost any portion of the body

If the skin cannot be released enough so that it can be brought together under the tube the gap may be closed later by free skin graft. Before a tube graft is cut loose it is often advisable to place a rubber tourniquet near the end to be cut and see if the tube receives sufficient blood supply from the other end. If it does not, more time should be allowed to elapse before the graft is cut. In some cases it may be advisable to cut the pedicle a little at a time over a period of several days to allow increased vascularity to develop in the opposite end When a long tubed graft is contemplated it may be advisable to leave the mid portion of the tube unseparated for a week or more so that additional blood supply to the tube is obtained through the mid portion. Tubed pedicle grafts or any type of pedicle graft should not be placed under tension. If there is evidence that the blood supply is not sufficient, the graft should be returned to its first location and left there until more blood supply develops. If sloughing occurs it is not apt to be so extensive when this is done

TRANSPLANTATION OF BONE AND CARTILAGE

These tissues may be transplanted independently bone being commonly obtained from a rib or tibia and cartilage from the cartilaginous portion of a rib or they may be transplanted as part of a pedicle graft Thus a portion of the clavicle may be left attached to a pedicle graft of skin from the neck and transplanted up to fill a defect in the jaw Cartilage is more commonly transplanted alone and may be obtained by cutting out a portion of the eighth costal cartilage and carving it to the desired shape A cartilage graft is commonly used for insertion under the skin of the nose to correct saddle nose

EXCISION OF PILONIDAL CYST

If the cyst is acutely inflamed, simple drainage should be performed and, during a quiescent period excision of the cyst and fistula should be done When a fistula is present it may be injected before operation with methylene blue to outline the course of the tract. An elliptical incision is made around the external opening of the fistula or centered at the level of the lower end of the sacrum. A flat cone-shaped block of

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tissue is excised rather widely around the tract down to the bone. If any connecting sinuses are present, as shown by scar tissue they are included in the dissection. The wound is packed open with vaseline gauze and must be kept packed until healing has taken place from within outward, a matter of several weeks

CHAPTER V

The Mouth, Tongue, and Salivary Glands

The Mouth, Tongue, and Salivary Glands

LESIONS OF THE MOUTH, TONGUE AND SALIVARY GLANDS

Harelip and Cleft Palate

Failure of closure of embryonal fissures results in many degrees of deformity of the mouth, from a small raphe or defect in the lip on one side to a wide open cleft on one or both sides. The cleft may extend on one or both sides to include the alveolus and may be associated with partial or complete cleft palate Double harelip and cleft palate are commonly complicated by protrusion of the premaxillary process and flaring of the nostrils

Infections of the Lip

Inflammation of the lip caused by the staphylococcus or streptococcus is common and is usually associated with a great deal of edema. Chancre and carcinoma of the lip should be differentiated from simple low grade inflammation.

Retropharyngeal Abscess

Not rarely in children an abscess may develop on the posterior pharyngeal wall beneath the prevertebral fascia. Swelling produces difficulty in swallowing and breathing, and with downward progression edema of the glottis appears Most of such abscesses are pyogenic, but tuberculosis of the cervical vertebrae may have to be ruled out.

Ludwig's Angina

This is an infection of the floor of the mouth that may develop from an infection of the mouth or may follow inflammation of the lymph nodes in the submaxillary triangle. There is brawny induration and edema, but pus forms late in the process and is always located beneath the mylohyoid muscle Eventually swelling becomes apparent in the floor of the mouth and in the tongue. The tongue is pushed upward and

backward and swallowing becomes difficult Edema of the glottis so often develops that it is characteristic of the disease Bronchial pneumonia is a common complication

Carcinoma of the Lip

This tumor which is of the epidermoid type is more common on the lower lip and begins as a small nodule that ulcerates gradually increases in size and becomes covered usually by a crust of dried secretion. Metastasis takes place to the submental and submaxillary glands, and later into the deep cervical nodes Because of the crossed lymphatic drainage from the lips into the submental glands the nodes on both sides may be involved by metastasis from a tumor on one side.

Ranula

Usually in children, a cyst may form under the tongue near the frenum, either in the midline or on one side Possibly developing from an abnormal duct of the sublingual gland, the cyst may reach considerable size, so that it interferes with articulation.

Tumors of the Tongue

Although papillomata and fibromata are occasionally seen on the tongue they are usually small and require no treatment unless they are an annoyance to the patient. Carcinoma of the tongue on the other hand, is common, particularly in men, and demands surgical attention The growth when first seen is usually in the form of an ulcer with indurated edges but occasionally it may appear as an indurated area or a warty growth. The tumor is usually located on the anterior two-thirds of the tongue near or on the edge. Metastasis of the tumor takes place to the glands in the submental and submaxillary regions, and later to the deep cervical nodes along the internal jugular vein.

The Tonsils

Acute inflammation of the tonsils is a common disease and during its course a peritonsillar abscess may occur In peritonsillar abscess a fluctuating mass develops near the upper pole of the tonsil and involves the anterior pillar and part of the palate.

Other types of infection of the tonsils are not infrequent. Diphtheria commonly begins on the tonsil, and Vincent's angina may cause necrosis of the superficial tissues of the tonsils Chancre of the tonsil is not rare. Tuberculosis may be found in routine microscopic examination.

Chronic inflammation of the tonsils is associated with the development of scar tissue in the tonsil itself and between the capsule of the tonsil and the surrounding tissue It may or may not be associated with enlargement of the tonsil. Tonsillar hypertrophy is commonly seen in

children and may cause respiratory disturbance and predispose to infections of the middle ear

Epidermoid carcinoma with ulceration and necrosis may begin in the tonsil and extend to the submaxillary and deep cervical glands.

The Salivary Glands

Injury to the salivary glands or ducts particularly the parotid, may be caused by an operation or an accidental wound, and may result in a salivary fistula.

Suppurative inflammation, again usually of the parotid gland and often on both sides, occasionally occurs and is not a rare complication following any major operation. This type of inflammation may or may not be associated with obstruction of the ducts In the case of the submaxillary glands however there is usually obstruction of Wharton s duct by a salivary calculus.

When a salivary calculus is present in the parotid duct, there is swelling of the gland and a stone may be located by probing the ducts or by X ray A stone in the submaxillary duct can usually be felt in the floor of the mouth along the side and base of the tongue, and its presence can be confirmed by X ray examination.

Tumors of the Salivary Glands

Mixed tumor is the common neoplasm of the salivary glands. It is found most commonly in the parotid gland but occasionally occurs in the submaxillary gland or even in the cheek or palate The tumor grows slowly and may reach enormous size. It is encapsulated, at least at first, and does not metastasize but has a strong tendency to recur unless completely removed.

Carcinoma of a salivary gland is sometimes seen, again most commonly in the parotid. It is a hard tumor that soon becomes fixed, grows rapidly and metastasizes to the deep cervical nodes.

TREATMENT AND TECHNIQUE

Harelip and Cleft Palate

Harelip should be repaired sometime during the first year of life unless complicated by cleft palate, in which case the operation should be done soon after birth. Not only does the presence of harelip and cleft palate make feeding difficult but early repair of the lip tends to pull the palate together and make its correction less difficult. The cleft palate should be operated on at about the end of the first year Operation should not be performed on babies in the presence of jaundice, and dehydration and anemia should be corrected by intravenous fluids and transfusions.

A simple method of repair, which is satisfactory in most cases of hare lip, is that devised by Husson and Rose (Figure 11) Anesthesia is induced by the open-drop ether method and continued by blowing ether vapor into the mouth through a tube connected to a pump. The first step of the operation is the mobilization of the upper lip and ala of the nose on each side of the cleft. This is accomplished by cutting through the



FIG. 11 *Husson and Rose Method of Repair of Harelip* A. Line of incisions that remove the mucous membrane of the cleft and lengthen the lip. B. The suturing is being completed.

mucosa on each side of the cleft. By the use of a periosteal elevator and dissecting scissors, the lip is loosened from the bone a considerable distance beyond the nose and mouth. Gauze may then be packed between the lip and the maxilla, and pressure made on the lip until the bleeding is under control. With a sharp knife, an incision is now made from the apex of the cleft on one side downward and outward, then, at a point about 3 mm. from the vermilion border the incision turns sharply to pass inward and downward across the lower margin of the cleft This incision, when straightened out, will represent the length of the lip A similar incision is made on the other side, using scissors in place of the knife if desired. Closure of the defect is now begun at the floor of the nostril on the inner side, where interrupted sutures of fine chromic catgut are introduced to bring the ala inward and reduce the size of the flared nostril. It is better to have the nostril a little larger than normal, since subsequent shrinking will reduce it to some extent. A traction suture may be inserted to bring and hold the two ends of the lip together

below until the suturing is completed The cut surfaces are brought together by three layers of sutures, catgut for the mucous side catgut for the muscular layer and silk for the skin. The two most important sutures are the one that adjusts the level of the nostril and the one that lines up the vermilion border of the lip When completed the suture line is painted with compound tincture of benzoin, and a Logan lip clamp is applied.

Double harelip may be satisfactorily repaired by Federspiel's method. Since this abnormality is commonly accompanied by a prominent pre-



FIG 12. *Stripping the Mucous Membrane from the Septum Preparatory to Excising a Wedge Shaped Segment so that the Premaxilla Can Be Pushed Backward*

maxilla, it is first necessary to replace this bone in its normal position by excising a wedge from the lower border of the nasal septum. An incision is made on the lower edge of the septum, the mucous membrane is stripped up for some distance on each side (Figure 12) and enough of the septum is cut out in the form of a wedge to allow the premaxilla to be pushed back between the maxillary bones. If the premaxilla is pushed back too far or turned inward there will be malocclusion of the teeth. The incision is sutured with fine catgut, and attention is then directed toward the lip The lip is mobilized well to each side of the nose and mouth as described above The principle of the operation is to use the mucous membrane and skin on each side of the cleft to construct the missing

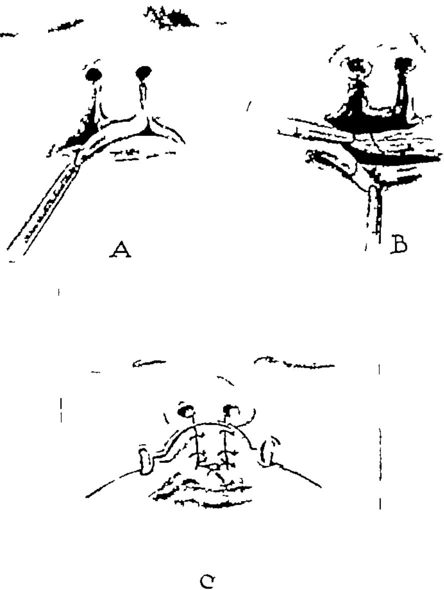


FIG. 13. A. The mucous membrane being removed from the premaxilla B The mucous membrane has been removed from the lateral sides of the cleft and relaxation incisions have been made. The dotted line indicates where the upper lip will be cut off before suturing C. The suture lines have been completed and a Logan lip clamp has been applied.

portion of the upper lip The mucous membrane is first pared off the premaxilla on each side and below so that only skin can be seen on the anterior surface (Figure 13A) Incisions are now made along the lateral margin of the cleft, starting at the nostril and extending down to the level of the lower border of the pared maxilla. At this point, lateral relaxation incisions may be made to allow the flaps turned down to be

pulled with their adjacent skin under the premaxilla, where they are cut off at appropriate lengths in a diagonal direction (Figure 13B) and sutured in place, using three layers of sutures as described above. The incisions should be painted with compound tincture of benzoin and the Logan lip clamp should be applied (Figure 13C) Early removal of the skin sutures results in minimum scarring

The Dieffenbach Warren operation is the standard procedure for the repair of cleft palate. An incision is made on each side, just inside the alveolar ridge and extending backward and outward almost to the anterior pillars of the tonsils Through these incisions a periosteal elevator is induced in front and behind the posterior palatine artery and nerve, the location of which will be recognized by a dimple. The elevator is worked inward, picking up the periosteum from the palate process *en route* until it can be protruded at the edge of the cleft (Figure 14A) Freeing of the mucous membrane and periosteum is now continued until the posterior palatine arteries are freed from the bone anteriorly to the incisive foramen With curved scissors, the soft palate is now thoroughly separated from the bone of the hard palate The margins of the cleft are denuded by paring with scissors or a sharp knife (Figure 14B) so that the nasal and oral surfaces may be sutured independently If there is excessive bleeding, strips of gauze may be inserted into the relaxation incisions while the suturing of the cleft is performed Suturing is begun by bringing the two halves of the uvula and upper surface of the velum together by interrupted sutures of fine catgut on the nasal surface and silk on the oral surface (Figure 14 C and D) This is continued forward to the full length of the cleft if tension will permit. If it is found that there is not sufficient relaxation, it is better to suture as far as can easily be done and close the remainder of the defect at a subsequent operation, since too much tension will result in sloughing of a portion of the palate. A small residual opening may be closed later by turning a flap from one side over it and suturing it in place.

Postoperatively after a harelip operation the lip is painted daily with compound tincture of benzoin and kept free from discharge No dressing should be applied If the Logan lip clamp has been used and held in place by flamed adhesive, it will usually require no adjustment. The child should be fed by a medicine dropper for about two days, after which nursing may be started. Additional fluid is given by hypodermoclysis or intravenously as required The sutures are removed from the skin about the sixth day but those in the mucous membrane may be left in a few days longer After an operation for cleft palate, spoon or dropper feeding is continued for a week and no solid food should be given until the incision is well healed usually at about three weeks The patient's nostrils should be kept clean by swabbing them carefully at least once a day

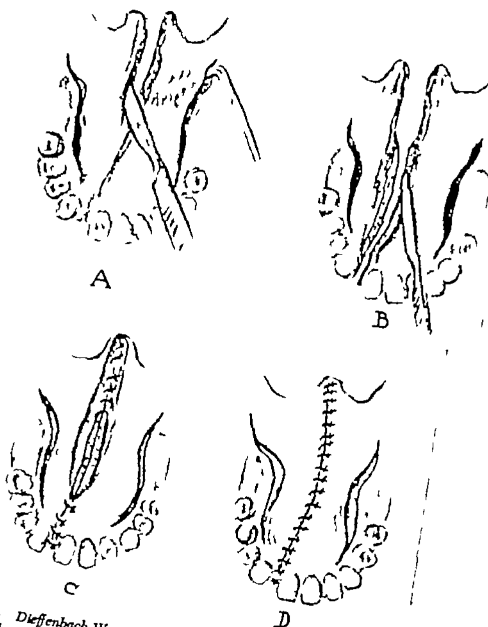


FIG 14 *Dieffenbach Warren Operation for the Repair of Cleft Palate* A Through incisions just inside the alveolar ridge a periosteal elevator is introduced to lift up the periosteum from the palate process. The mucous membrane and periosteum are further being freed with a knife B The margins of the cleft are denuded of mucous membrane C The nasal side of the cleft is being sutured with catgut and a few sutures have been placed near the lower margin on the oral side D The suture lines have been completed.

Infections of the Lip

Pyogenic infections of the lip or any part of the face should always be treated conservatively by hot compresses and sulfonamides or penicillin. Incision of an abscess is apt to result in the spread of the infection by way of the ophthalmic veins to the cavernous sinus with resulting sinus thrombosis.

Retropharyngeal Abscess

Pyogenic retropharyngeal abscess should be drained through the mouth. Under general anesthesia, a mouth gag is inserted and, with the aid of a tongue depressor a longitudinal incision is made in the median line. Any pockets present are broken down with the finger No drainage is necessary An aspirator should be used and it is best to have the head in a dependent position—that is, hanging back over the table—during the operation. A tracheotomy set should always be available for emer gency use since obstruction of the glottis may come on very rapidly

Ludwig s Angina

When possible the etiologic factor should be found and treated. In the early stages, in addition to hot wet packs beneath the chin, large amounts of penicillin should be given. Occasionally it is possible to drain an abscess in the floor of the mouth by an incision in the mouth, but in a well-developed case of Ludwig s angina, wide drainage must be established by incision from without. It is not safe to wait until fluctuation can be felt before resorting to surgery If improvement does not occur within a few hours under medical therapy one should be prepared to operate In some cases because of rapidly developing swelling it may be necessary also to do an emergency tracheotomy Drainage is best established by making a wide transverse incision just above the level of the hyoid bone and another incision from the midpoint of this to just below the mandible The mylohyoid muscle is split and the tissues are widely opened. Little or no pus may be obtained at operation. No su tures or drains are used Postoperatively wet dressings penicillin, or sulfonamides should be continued, and a tracheotomy set should be kept ready for emergency use

Carcinoma of the Lip

The lesion on the lip may be removed by a V-shaped incision, which extends well into normal tissue (Figure 15 A, B and C) After the wedge of tissue has been excised the edges of the incision should be brought together carefully so that there will be alignment at the mucocutaneous border Three layers of sutures may be used, silk for the mucous and cutaneous surfaces, and catgut for the muscular layer In addition, where the lip is under considerable tension, through and through tension sutures of silkworm may be inserted. At least a third of the lip may be removed in this way and in time the shortened lip will stretch and elongate so that there is little deformity When it is necessary to excise so much of the lip that the incision cannot be brought together in the case of the lower lip a wedge of the upper lip containing the mucosal border may be turned down and sutured in place (Figure 15

D E, and F) The incision made to remove this wedge stops short about 5 cm. from the lip margin so as to leave a source of blood supply The upper lip will be shortened in this procedure If the carcinoma is on the upper lip a similar operation may be done borrowing tissue from the

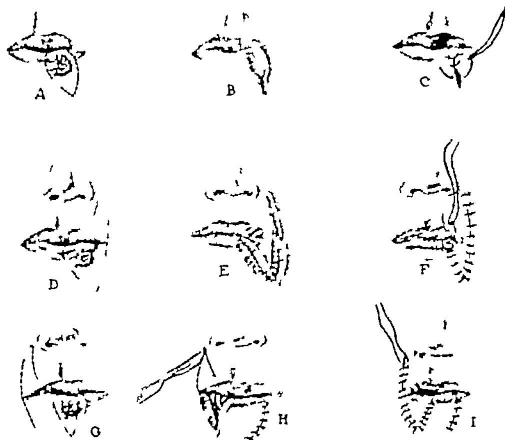


FIG. 15 A, B and C. Removal of a growth from the lower lip by a V-shaped incision, and stages in suturing the incision D E, and F Removal of a growth from the lower lip by a V-shaped incision and method of closing the defect by pulling down a segment of the upper lip G H and I. The use of the same principle to close a defect when the growth is in the center of the lower lip.

lower lip When it is necessary to excise a large amount of tissue from the center of the lip this operation may be done on both sides (Figure 16) (Estlander s operation)

If the entire lip must be removed, the flaps instead of being wedge-shaped, are made square turned down and sutured together As a rule unless the lesion is small it is more satisfactory to treat it by radiation, or if this is not successful, it may be widely excised by the endotherm knife and the defect closed later by a plastic procedure Block resection of the lymph glands, of the suprahyoid region, and of the neck was formerly done routinely as a preliminary to the operation on the lip

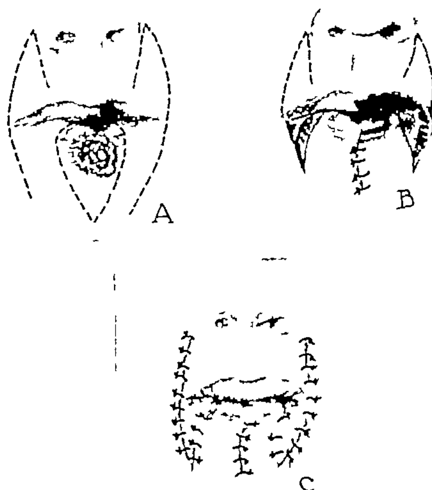


Fig 16. *Estlander's Operation.* Removal of a growth in the center of the lower lip and closure of the defect by turning down the outer portion of the upper lip on both sides

but at the present time most surgeons depend almost entirely on radiation therapy for the treatment of the involved glands

Ranula

A longitudinal incision is made over the cyst and it is excised as completely as possible If any bleeding vessels are present they are caught and tied with fine catgut The wound is left open

Tumors of the Tongue

Small benign tumors may be removed by an elliptical incision and the wound closed by a few sutures. Carcinoma of the tongue should be treated by radiation, but surgery is often indicated in conjunction with it. When the tumor is located in the usual position, near or on the edge

of the tongue it may be excised by making a wedge shaped incision with a knife and bringing the edges of the wound together by interrupted sutures using silk for the two mucosal layers and fine catgut for the muscular layer (Figure 17) Radiation therapy should be used in the



FIG. 17 A. Excision of a tumor of the tongue by a V-shaped incision. B. Closure of the defect.

treatment of the regional lymph glands the submaxillary and the submental groups and the deep cervical nodes, but surgical removal of the glands may be indicated, particularly when enlargement of the glands occurs later when the original lesion has healed

The Tonsils

Peritonsillar abscess should be incised but one should not make the mistake of operating too soon when pus has not yet formed. The operation is done without anesthesia, or after topical application of cocaine and preferably with the patient in a sitting position. An incision about 1 cm. long is made in the most prominent part of the swelling which will usually be near the upper part of the anterior pillar A small hemostat is quickly introduced into the incision and passed inward to enter the abscess. When the blades are separated, pus under pressure should pour out.

Chronic infection of the tonsils should be treated by tonsillectomy If acute infection is present in the tonsils operation should be postponed, this is also true if the patient has a cold, as children with enlarged adenoids so often do The possibility of a familial tendency to bleed should be investigated, and it is the custom to determine the bleeding and clotting time preoperatively

Local anesthesia is most satisfactory in the adult for this operation, but in children ether anesthesia should be used When the operation is

performed under local anesthesia, the patient is placed in a sitting position. By the use of a special needle with a long shank, 1 per cent procaine hydrochloride is injected into the anterior pillar the upper and lower poles and the tonsillar bed. The tonsil is grasped with a tenaculum and an incision is made at the junction of the tonsil and the anterior pillar extending up around the upper pole of the tonsil (Figure 18A) A dis-

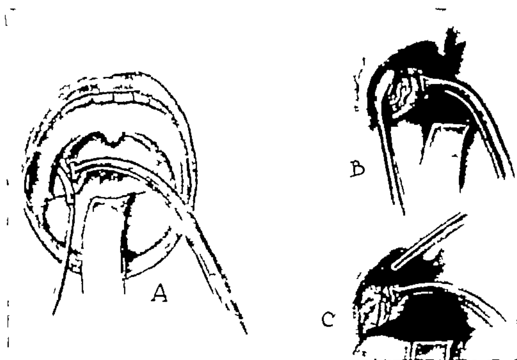


FIG. 18 *Tonsillectomy* A An incision is being made in the anterior pillar B The tonsil is being enucleated from its bed C. A snare is being applied.

sector is gently insinuated into the incision and worked up and down until the tonsil is everted from its bed (Figure 18B) A snare is now passed around the tenaculum and tonsil, and as it is tightened it completes the dissection of the tonsil (Figure 18C) A gauze sponge is held in the tonsillar fossa for a few minutes after which it is removed and the fossa is inspected for bleeding points using a pillar retractor for exposure If bleeding continues the vessel can sometimes be grasped with a hemostat and tied in other cases it is necessary to put in a transfixion suture just above the point of hemorrhage When bleeding is under control the other tonsil is removed.

When the operation is done under general anesthesia, the patient is placed on his back with the head somewhat hyperextended, a mouth gag is inserted before the operation is started, and any mucus that has welled up into the pharynx is removed by suction. The tonsils are removed as described above and when bleeding is under control a finger is inserted into the nasopharynx to determine whether adenoids are pres

ent and obstructing the air passages. If so they are removed with an adenotome

If operation has been performed under general anesthesia the patient on being returned to bed is placed on his abdomen with the head turned to one side, and kept under careful observation until he is conscious Secretion or blood should not be allowed to collect in the back of the throat where it can be inhaled Excessive or prolonged bleeding not controlled by pressure with a sponge in the tonsillar fossa requires surgical treatment. Usually an anesthetic must be administered and the field cleared until the bleeding point is identified when a suture ligature is applied. In the case of an adult the application of 5 per cent cocaine to the tonsillar fossa usually enables one to remove the blood clot and locate and stop the bleeding by clamp or ligature If the bleeding is not too profuse a sponge of absorbable gauze placed and held in the tonsillar fossa may be effective If serious bleeding follows the removal of adenoids, a postnasal pack must be inserted—a ball of gauze pulled up into place by strings attached to catheters introduced through each nostril This procedure can be carried out in adults after spraying the nose with 2 per cent cocaine but for children a general anesthetic is required The pack is removed within twelve to twenty four hours by inserting a curved clamp up behind the soft palate then grasping the pack and pulling it out of the mouth, dragging the thread behind it.

Carcinoma of the tonsil if confined to the tonsil, should be treated by tonsillectomy on the involved side followed by radiation therapy If there has been extension of the tumor to the palate and pillar a small piece of tissue should be excised for diagnosis, the bleeding area cauterized with the diathermy and the lesion treated by radiation, which should include treatment of the submaxillary and cervical glands.

The Salivary Glands

Surgical Anatomy of the Submaxillary Gland The gland is about the size of a small walnut, but in the presence of tumors or inflammation it may be greatly enlarged. It lies under the deep cervical fascia and extends up under the body of the mandible forward to the anterior belly of the digastricus. Its posterior margin is separated from the parotid by the stylomandibular ligament. A deep process extends inward above the mylohyoid muscle. The external maxillary artery crosses the gland in a groove on its posterior border Crossing the gland also are the anterior facial vein and filaments of the facial nerve The submaxillary duct is about 5 *cm* long Beginning on the deep surface of the gland, it runs forward between the hyoglossus and genioglossus and the mylohyoideus, then between the sublingual nerve and the genioglossus and opens at the apex of a papilla near the frenulum linguae.

Fistula of the Submaxillary Gland or Duct A fistula that opens into the mouth requires no treatment so long as the opening of the fistula or the normal opening of the duct is large enough to permit secretion to escape If a fistula opens to the outside or if the internal drainage is inadequate, the submaxillary gland should be removed.

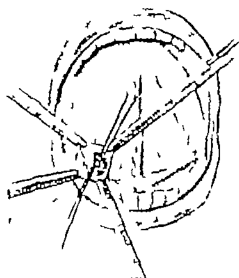


FIG 19 *Removal of Calculus from Submaxillary Duct* The mucous membrane of the floor of the mouth has been incised an incision has been made in the duct, and stay sutures have been put in to keep the duct open The stone will be removed by probing and pressing on the duct. Whenever possible, the incision in the duct should be made directly over the stone.

Inflammation of the Submaxillary Gland Acute inflammation of the gland should be treated conservatively until it subsides but if an obstructing stone is present it should be removed. If chronic inflammation persists it is necessary to remove the gland

Calculus in the Submaxillary Gland or Duct Frequently the stone can be felt in the floor of the mouth and an incision may be made through the mucous membrane of the mouth (Figure 19) and the wall of the duct down to the stone. In some cases simple dilatation of the duct and manual pressure are enough to expel the stone without incision. When the stone is shown by X ray to be located near the gland, it must be approached by an incision through the skin below the mandible In some cases particularly when the stone is in the gland itself it may be simpler to remove the gland.

Tumors of the Submaxillary Gland These may be mixed tumor or carcinoma but simple cysts may also be encountered and the preferred treatment is excision of the gland. An incision is made from near the median line below the jaw back to just below the angle of the jaw After the platysma is cut through, the flap is retracted upward. Incision of the deep cervical fascia over the gland reveals the external maxillary artery and anterior facial vein. The fibers of the facial nerve should be watched for since if they are cut paralysis of the side of the mouth may take place The artery and vein should be cut and ligated, the gland separated from the under side of the mandible and the stylomandibular ligament which separates the submaxillary from the parotid, should be cut The hypoglossal and lingual nerves should be guarded. The gland

should be followed forward until it is freed when the duct is cut and ligated The wound is closed in layers without drainage

Surgical Anatomy of the Parotid Gland The gland is enclosed in dense fascia derived from the cervical fascia and from this capsule processes are sent inward dividing the gland into lobes. Because of this fascial arrangement the parotid cannot be shelled out like the other salivary glands. The facial nerve and its branches the posterior facial vein and the external carotid artery enter the gland and divide into branches in its substance The facial nerve enters at about the level of the external auditory meatus and passing forward across the external carotid artery and the facial vein it divides into its main branches the latter passing upward forward and downward The external carotid artery which is crossed by the facial nerve and lies deep to the posterior facial vein gives off its terminal branches at the level of the neck of the mandible The parotid duct which is about 5 cm long lies about 2 cm below the zygomatic arch and crosses the masseter muscle from the anterior part of the gland to the anterior margin of the muscle It then passes through the buccinator muscle to reach the mucous membrane of the cheek, where it enters the mouth opposite the second upper molar tooth.

Fistula of the Parotid Gland Fistula due to injury usually closes spontaneously If it does not do so after several weeks the fistulous tract may be dissected out and the resulting opening closed by sutures

Fistula of the Parotid Duct If the fistula is the result of a wound and is seen immediately an attempt should be made to close the cut ends of the duct by end to-end suture over a piece of ureteral catheter Very fine catgut should be used for this purpose and the sutured duct should be supported by careful closure of the overlying tissues.

Chronic external fistula offers a difficult surgical problem, and many operations have been described for its correction The simplest procedure and one that is successful in some cases consists of converting the external fistula into an internal fistula by causing necrosis to take place in the tissue between the fistula and the mouth. With the use of two straight needles, a silk thread is passed from the fistulous opening into the mouth in such a way that the loop encloses the fistulous tract. The needles are removed and the thread in the mouth is tied tightly enough to cause pressure necrosis

Another method of producing an internal fistula is to pass a piece of rubber tube from the fistulous opening into the mouth, using a trochar and anchoring the tube in place by silk sutures. It is then cut off at the level of the fistulous tract and at the level of the oral mucosa

Suppurative Parotitis Many cases of acute surgical mumps will subside under radiation therapy but when pus forms the abscess should be

drained. An incision is made from a point 2 cm. in front of the ear just below the zygomatic process and extending back to the ear and then downward below the angle of the jaw The skin and superficial fascia are stripped forward the fascia covering the gland is split horizontally at several levels, and the gland is punctured with a hemostat at the point of fluctuation. If the pus cannot be located it may be necessary to puncture the gland in several places opening the blades of the hemostat a little each time Often multiple areas of suppuration are present. The wound is closed loosely by a few interrupted sutures leaving a small soft rubber drain in place.

Calculus of the Parotid Gland and Duct To remove a stone from the gland the skin incision described above may be used. After incision of the fascia, the gland may be explored by puncturing it with a needle until the calculus is located The gland tissue in the region is then gently separated using a great deal of care to avoid the nerve until the stone is exposed. When it has been freed it is grasped with forceps and lifted out. Multiple stones may be present The wound is closed without drainage

A calculus in the parotid duct, when located in the distal portion may be removed by an incision through the inner surface of the cheek. An incision is made directly over the stone, using counter pressure from the outside After it is extracted with a small curette or forceps the wound is left open.

A stone located farther back in the duct must be approached from the outside by a horizontal incision over the buccinator muscle, using care to avoid the branches of the facial nerve. The stone is located by palpation, a small lengthwise incision is made in the duct, and the stone is lifted or milked out. The opening in the duct is closed by very fine catgut sutures which are inserted through only the outer layers of the duct wall. The overlying tissues are carefully sutured and the wound is closed without drainage Salivary fistula may occur but it usually closes spontaneously if the remainder of the duct is patent. In all operations for fistula, the patient should be fed fluids through a tube and the jaws should be immobilized in order to minimize salivary secretions

Tumors of the Parotid Gland The most common of these, the mixed tumor should be removed surgically An incision of the type described under suppurative parotitis is made, and if necessary an extension can be made backwards just below the ear Skin and superficial fascia are raised from the surface of the tumor exposing the fascia covering the gland. If the tumor is comparatively small, the fascia is incised over it parallel to the fibers of the facial nerve. Mixed tumors are, in the early stages at least encapsulated, and the cleavage plane formed by this fibrous covering should be located and followed around the tumor (Figure 20) In patients on whom previous operation has been done, or in those with

very large tumors such a cleavage plane may not be demonstrable and it is necessary to remove a shell of parotid gland tissue with the tumor. The course of the facial nerve should be kept in mind and in many cases it is advisable to expose the nerve at the posterior margin of the gland so that it can be protected. When the nerve passes into the tumor it is necessary to sacrifice the nerve and the patient should be told in advance that facial paralysis may follow the operation. Since bleeding from the gland may be profuse in clamping the vessels encountered the

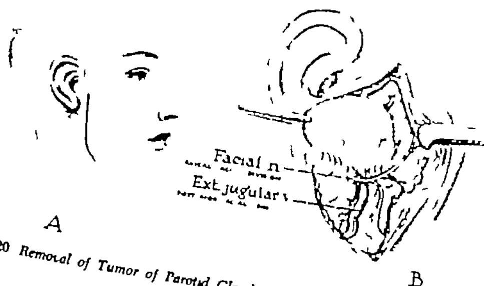


Fig. 20 *Removal of Tumor of Parotid Gland.* A. Incision. B. Exposure of the tumor and gland.

nerve fibers should be watched for at all times. After removal of the tumor the fascia covering the gland is sutured and the skin is closed without drainage. A pressure dressing should be applied.

Carcinoma of the parotid gland responds to radiation, differing in this respect from mixed tumor but since the arrest of the growth is usually temporary this treatment should be reserved for inoperable or recurrent tumors. Whenever possible the gland, tumor and regional lymph nodes should be totally removed. The skin incision is the same as described above but to remove the lymph glands the incision is extended downward in front of the sternocleidomastoid and forward to the midline. Dissection of the parotid is done from behind forward and upward, and should include the enveloping fascia of the gland. The stylohyoid and the posterior belly of the digastric muscles should be identified and the parotid fascia separated from the sheath of the sternocleidomastoideus. The external carotid artery, which is exposed in this region, may be ligated and cut if necessary but the hypoglossal nerve,

drained. An incision is made from a point 2 cm. in front of the ear just below the zygomatic process and extending back to the ear and then downward below the angle of the jaw The skin and superficial fascia are stripped forward the fascia covering the gland is split horizontally at several levels and the gland is punctured with a hemostat at the point of fluctuation If the pus cannot be located, it may be necessary to puncture the gland in several places, opening the blades of the hemostat a little each time. Often multiple areas of suppuration are present. The wound is closed loosely by a few interrupted sutures, leaving a small soft rubber drain in place.

Calculus of the Parotid Gland and Duct To remove a stone from the gland, the skin incision described above may be used After incision of the fascia, the gland may be explored by puncturing it with a needle until the calculus is located The gland tissue in the region is then gently separated, using a great deal of care to avoid the nerve until the stone is exposed. When it has been freed it is grasped with forceps and lifted out Multiple stones may be present. The wound is closed without drainage

A calculus in the parotid duct, when located in the distal portion, may be removed by an incision through the inner surface of the cheek. An incision is made directly over the stone, using counter pressure from the outside After it is extracted with a small curette or forceps the wound is left open

A stone located farther back in the duct must be approached from the outside by a horizontal incision over the buccinator muscle, using care to avoid the branches of the facial nerve. The stone is located by palpation, a small lengthwise incision is made in the duct, and the stone is lifted or milked out. The opening in the duct is closed by very fine catgut sutures, which are inserted through only the outer layers of the duct wall. The overlying tissues are carefully sutured and the wound is closed without drainage. Salivary fistula may occur but it usually closes spontaneously if the remainder of the duct is patent. In all operations for fistula, the patient should be fed fluids through a tube and the jaws should be immobilized in order to minimize salivary secretions.

Tumors of the Parotid Gland The most common of these the mixed tumor should be removed surgically An incision of the type described under suppurative parotitis is made and if necessary an extension can be made backwards just below the ear Skin and superficial fascia are raised from the surface of the tumor exposing the fascia covering the gland. If the tumor is comparatively small, the fascia is incised over it parallel to the fibers of the facial nerve Mixed tumors are in the early stages at least encapsulated, and the cleavage plane formed by this fibrous covering should be located and followed around the tumor (Figure 20) In patients on whom previous operation has been done, or in those with

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which lies superficial to the artery should be protected. The separation of the fascia is continued around the posterior surface of the gland, cutting the superficial temporal vessels in front of the ear. As the anterior margin of the gland is encountered, the parotid duct is ligated and cut, allowing the gland to be separated from the masseter. The parotid extends forward very close to the submaxillary gland and is partitioned off from it only by a layer of fascia known as the stylomandibular ligament. The deep surface of the gland gives off a projection that lies close to the pharynx, and other projections may extend into the mandibular fossa. All of these projections must be carefully dissected out without injury to the internal jugular vein, the internal carotid artery and the ninth to twelfth cranial nerves which lie deep to the gland structure. It may be necessary to remove a small amount of bone from the posterior ramus of the mandible along with the condyle, and this can best be done by stripping the muscle from the bone passing a Gigli saw in front of the neck of the condyle and out beneath the ramus. Almost 2 cm. of bone may be sawed off the posterior edge of the jaw and the condyle disarticulated. The stylomandibular ligament, which separates the submaxillary from the parotid, should be cut, and the hypoglossal and lingual nerves should be guarded. The gland should be followed forward until it is freed when the duct is cut and ligated. The wound is closed in layers without drainage.

Surgical Anatomy of the Sublingual Gland This the smallest of the three salivary glands, is located lateral to the frenulum linguae beneath the mucous membrane of the mouth and is in contact with a depression on the inner side of the mandible. It lies on the mylohyoideus and is adjacent posteriorly to the submaxillary gland. It opens by from ten to twenty small ducts on the crest of mucous membrane (plica sublingualis) caused by the gland. A few of the ducts also join together to form a larger sublingual duct, which opens into the submaxillary duct. The lingual nerve lies just medial to the gland.

Fistula and Calculus of the Sublingual Gland or Duct An internal fistula usually causes no disturbance, but if an external fistula is present the gland should be removed. Calculi in a duct or in the gland may be removed by making an incision through the floor of the mouth down to the gland. In many of these cases however removal of the gland is indicated.

Tumors of the Sublingual Gland Removal of the gland is indicated, and is accomplished by making an incision in the floor of the mouth from the medial line laterally over the plica sublingualis. The gland, which lies just beneath the mucous membrane is grasped with Allis forceps and separated from its bed. The duct that lies toward the median line is cut and tied. A few catgut sutures are placed to bring the mucous membrane together

CHAPTER VI

The Neck

The Neck

LESIONS OF THE NECK

Anomalies

Cystic Hygroma The soft, fluctuating mass known as cystic hygroma, seen not infrequently in children, may be more properly classified as a lymphangioma. It usually occurs in the posterior triangle of the neck, in the axilla, or in the submaxillary region, and consists of multiple intercommunicating cysts. Many of these tumors disappear before the age of puberty probably as a result of an obliterative inflammation.

Branchial Cleft Cyst and Fistula Along the side of the neck in front of the sternocleidomastoid muscle cysts may develop that are supposed to be derived from the branchial clefts or according to some authorities, from remnants of the thymic duct. Occasionally a cyst may be located farther forward, or in place of the cyst a fistula may be present. The fistulous tract extends inward in the region of the great vessels and may even connect with the pharynx. Inflammation may occur in a branchial cleft cyst so that the clear fluid normally present may become purulent and the wall of the cyst which is usually thin, may be thickened. Rupture of a cyst to the outside or incomplete removal of it causes a fistula. The injection of the tract with a radiopaque substance such as lipiodol may help in outlining the course of the tract.

Wounds of the Neck

Severe lacerated wounds of the neck commonly produced with suicidal intent are often encountered. When the cut is on the lateral side of the neck, the great vessels may be cut and the patient is usually in shock from the severe hemorrhage. Along with the large vessels, the recurrent laryngeal nerve may also be divided and there may be persistent unilateral paralysis of the vocal cords A cut on the front of the neck usually passes at least part way through the trachea, because of its projection forward, and the vessels are not so likely to be severed. When

the trachea is completely divided the lower portion has a tendency to retract beneath the sternum Air and blood pass in and out of the opening in the trachea and the patient may be rapidly asphyxiated. When the wound is higher up, the lower part of the pharynx may be opened and the epiglottis cut.

The Cervical Lymph Glands

Carcinoma of the lip metastasizes to the submaxillary and submental lymph glands and then into the deep cervical chain and block resection of the neck to remove these glands may be indicated Enlargement of the cervical glands may also occur in Hodgkin s and other diseases and it may be necessary to remove a gland for diagnosis. Tuberculosis of the cervical glands may be treated by complete surgical removal of the infected glands. Roentgen therapy general hygienic measures and heliotherapy are often curative.

Cervical Rib

In the presence of an extra rib in the cervical region at the level of the seventh certical vertebra, the scalenus anterior muscle may cause pressure on the brachial plexus. Indeed, such pressure may sometimes be produced by the muscle when the normal number of ribs is present. The condition may be unilateral or bilateral.

Pharyngo-Esophageal Diverticulum

A diverticulum may develop at the junction of the pharynx and esopha gus, or from the lower end of the pharynx. Such a sac is in free com munication with the lumen of the esophagus and during deglutition catches and holds food and liquids. Occasionally the diverticulum may be so large as to produce a noticeable mass usually on the left side of the neck.

The Carotid Gland

The carotid body normally forms a mass about .5 cm. in diameter on the posterior surface of the bifurcation of the carotid artery A tumor usually classified as a paraganglioma may develop in it, forming a rounded pulsating mass that pushes out the sternocleidomastoid muscle.

The Thyroid Gland

Anomalies of the Thyroid Gland Aberrant thyroid tissue may develop along the tract of migration of the thyroid gland, that is, from the base of the tongue to the normal location in the neck, but such tissue may also rarely be seen in the posterior part of the neck the superior mediastinum, the respiratory passages from the pharynx down, or even in the wall of the esophagus. In such cases the normal thyroid gland may be present or

absent. Aberrant thyroid tissue located at the base of the tongue near the foramen cecum is known as lingual goiter

Cyst and Fistula of the Thyroglossal Duct At any point between the foramen cecum and the thyroid gland a cyst may develop from vestigial remnants of the thyroglossal tract. Such cysts are located in the midline of the neck and are usually below the level of the hyoid bone.

Acute Inflammation of the Thyroid Gland Although inflammatory changes may occur in the thyroid gland during the course of such conditions as acute tonsillitis or acute rheumatic fever suppuration is rare If an abscess does form in the thyroid gland and is not surgically drained, it may perforate into the mediastinum, the trachea the larynx, or the esophagus.

Chronic Thyroiditis In the rare condition known as Riedel's Struma there is diffuse irregular enlargement of the thyroid gland and stony hardness due to replacement of most of the glandular tissue by connective tissue.

Struma Lymphomatosa of Hashimoto is a condition in which there is moderate enlargement of the thyroid gland due largely to diffuse lymphoid infiltration.

Goiter Three types of enlargement of the thyroid gland are commonly differentiated, and although from a pathologic point of view there is some overlapping among the groups, the classification has clinical importance.

Diffuse goiter with involution, also known as simple or colloid goiter is characterized by uniform enlargement of the entire gland. The tissue is soft and amber in color due to the presence of colloid.

Nodular or so-called adenomatous goiter is characterized by the development in the gland of more or less encapsulated nodules of thyroid tissue. The masses of tissue are rounded and may be single or scattered diffusely through the gland, and at the same time the gland itself usually shows evidence of involution by its excess colloid content. The microscopic structure of the nodules may be that of the normal thyroid gland or of the fetal or colloid type and hyperplasia may be seen in the nodules or in the surrounding glandular tissue. The presence of hyperplastic tissue, although noted more commonly in toxic nodular goiter is not proof of hyperthyroidism since such changes are so commonly found in nontoxic nodular goiter Nodular goiter has a great tendency to cause pressure symptoms by impinging on the trachea and esophagus, and by enlarging downward it may extend into the mediastinum. In nodular goiter there are commonly seen scattered throughout the gland areas of hemorrhage fibrous tissue proliferation, calcification, and cyst formation.

Diffuse goiter with hyperplasia, also known as exophthalmic goiter or Graves disease, is characterized by an enlargement of the thyroid gland, usually moderate in degree and sometimes even c ed to one lobe of the gland The organ is apt to be smoothly enl ighly vascular

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and when cut has a compact beefy appearance much different from the amber translucent colloid goiter If the patient has had a period of treatment by Lugol's solution however the characteristic appearance may be lost and the gland may resemble one with involution.

Tumors of the Thyroid Gland When a malignant tumor develops in the thyroid, it is nearly always in a gland already the seat of goiter and almost all of these tumors are carcinomatous. The tumor may arise from an adenoma and remain encapsulated for a period of time but it later extends into the surrounding tissue. In many instances the tumor appears to be diffuse in its origin from the beginning, and although as a rule the thyroid involved by malignant disease feels hard and fixed to the neighboring tissues in the rapidly growing tumor the mass may be even softer in consistency than the normal thyroid. Pressure symptoms are common in malignant disease of the thyroid often operation is performed to relieve these and the diagnosis of malignancy is made only by the microscopic study of the tissue removed. Metastasis to the lungs, mediastinum, and bones may occur before there is any palpable enlargement of the regional lymph nodes

The Parathyroid Gland

The parathyroid glands usually four in number are located two on each side of the trachea on the posterior and medial surface of the thyroid gland. The lower one is usually near the inferior pole of the gland and the upper one about one-third of the way down on the gland. They are yellowish or brownish in color about 6 × 3 mm. in size and are flattened and oval in appearance. Lying under the capsule of the thyroid gland, they are adherent to the thyroid and may even be embedded in it. Occasionally the parathyroids particularly the inferior pair may be located below the level of the thyroid gland, where they are commonly in relation to one of the inferior thyroid veins

Tumors of the Parathyroid Benign adenoma may develop in the parathyroid glands and produce striking systemic changes among which are osteitis fibrosa cystica, and hypercalcemia.

TREATMENT AND TECHNIQUE

Anomalies

Cystic Hygroma As some of these masses disappear spontaneously it is wise to keep the patient under observation and watch the progress of the tumor before advising operation. The usual site of the mass is just above the clavicle in the posterior triangle of the neck, and a transverse incision is made in that region. Having reached the wall of the cyst, the surgeon continues the dissection carefully bearing constantly in mind the anatomy of the region. The mass may pass up into the neck or down

over the chest wall under the clavicle, and a very extensive time-consuming dissection may be necessary On one occasion I worked for over two hours in removing such a tumor from the neck region alone, and at a subsequent sitting spent about the same length of time in removing the portion that extended under the clavicle and over the chest wall to the axilla. If it is impossible to remove such a tumor completely X ray treatment has value but must be used guardedly in children.

Branchial Cleft Cyst and Fistula These should be excised as thoroughly as possible A transverse incision is made, which bifurcates to pass around the opening of the fistula when present. The anterior border of the sternocleidomastoid muscle, which is usually located near the opening of the fistula, is retracted posteriorly, the deep layer of cervical fascia is incised, and at this level the cyst is usually encountered. If no infection has been present in the cyst, the wall is thin. Although no harm is done by spilling its contents, it is more difficult to be sure that the cyst is entirely removed if it has been ruptured, so the dissection should be done with care. When a fistula is present, it should be injected with a dye before operation· if this dye appears in the pharynx one knows that the fistula connects with the pharynx and the dissection must be made to its inner opening The tract may pass between the internal and external carotid arteries or may be lateral to the great vessels. If a finger is inserted into the pharynx it will aid in tracing the tract down to its origin. After the fistula is excised down to the surface of the pharynx, it is clamped and ligated, a small rubber drain is inserted, and the wound is closed, using catgut for the subcutaneous tissues and dermal for the skin.

Wounds of the Neck

In severe lacerated wounds of the neck the prime considerations are to stop the hemorrhage and to insure an adequate airway The edges of the wound should be separated and bleeding vessels clamped with hemostats. When an incised wound of the trachea is present and the latter is filled with blood, the edges of the opening should be grasped and the clot removed with suction. The wound should now be cleaned and chloroform anesthesia given if necessary At the same time measures should be taken to combat the shock and loss of blood. If necessary to gain proper access to the large vessels the wound may be enlarged so that an exact knowledge may be obtained of the structures injured. Each bleeding vessel is carefully caught and tied, and the pharyngeal wall and epiglottis if injured, are sutured. If the trachea is partly cut in two the opening may be closed by passing sutures around the terminal rings and bringing the edges of the wound together If the trachea is completely severed and the ends can be brought together without difficulty after the neck has been bent, an attempt may be made to suture the two

ends together, using interrupted catgut sutures. If this cannot easily be done, a tracheotomy tube may be anchored in the lower segment and the trachea may be repaired at a subsequent operation. Foreign bodies are carefully sought for and removed, and the wound is closed loosely by interrupted sutures leaving in a soft rubber drain if there has been much contamination.

Metastatic Carcinoma of the Cervical Lymph Glands

For a carcinoma of the lip situated at or near the midline, bilateral suprahyoid removal of the glands may be done. If the glands thus removed show carcinomatous involvement, removal of the deep cervical glands may be indicated. For the suprahyoid operation an incision is made extending from the anterior edge of the sternocleidomastoid muscle on one side, across the anterior aspect of the neck just above the level of the hyoid bone, to the anterior margin of the sternocleidomastoid muscle on the other side From the upper edge of the incision a flap is dissected up which includes the platysma along with the skin and subcutaneous tissue. At the lower border of the mandible from the anterior margin of one sternocleidomastoid to the other the deep fascia is cut preparatory to being turned downward as a flap carrying the lymph nodes, areolar tissue, and submaxillary gland with it. The submental space is first cleared between the anterior bellies of the two digastric muscles, the dissection extending up under the symphysis of the mandible to remove the lymph nodes in this region. The dissection proceeds laterally over the anterior belly of each digastric muscle, the external maxillary vessels are identified, cut, and ligated where they cross over the mandible, and the submaxillary space is opened. The mandibular branch of the facial nerve should be watched for and retracted out of the way The submaxillary gland and regional lymph nodes are freed from the inner surface of the mandible. Working laterally from the anterior belly of the digastricus the dissection extends onto the lateral portion of the mylohyoid. When the mylohyoid has been cleared in this region, its edge is retracted medially so that the anterior deep portion of the submaxillary gland can be mobilized. This part of the gland is freed, the submaxillary duct is isolated, clamped, cut, and tied, and the submaxillary gland with the neighboring lymph nodes can be further displaced. In this dissection the lingual nerve will be encountered as it arches under the mandible the small branch to the submaxillary gland is cut, but the main nerve is protected. The hypoglossal nerve, which passes below the submaxillary gland on the hypoglossus muscle should be watched for and protected if possible. During all of this dissection, numerous small vessels may be encountered, which should be carefully clamped and ligated. The submaxillary gland and nodes are pulled downward and separated from the parotid gland, and then dis

section of the entire mass is continued downward until the mylohyoid and hypoglossal muscles are cleared from mandible to hyoid bone and from the posterior belly of the digastricus on one side to the same region on the other side. The wound is closed by interrupted sutures of silk, and a soft rubber drain may be left in place for twenty four hours.

If the glands removed from the suprahyoid and submaxillary regions show carcinoma, removal of the deep cervical glands is next performed, usually on one side The incision already present is extended backward as far as the anterior edge of the trapezius muscle and at a midpoint between the trapezius and the center of the hyoid bone a perpendicular incision is made extending downward across the sternocleidomastoid muscle to the clavicle. This incision at its clavicular end will be near the posterior edge of the sternocleidomastoid. From the incision, flaps are now reflected forward and backward, the former to the ribbon muscles of the neck and the latter to the anterior margin of the trapezius. All glandular and areolar tissue is removed down to the prevertebral fascia. About 4 cm above the clavicle the sternocleidomastoid muscle is cut across and the internal jugular vein is ligated and cut. The stump of the muscle is turned downward and the lymph glands in the supraclavicular region are removed. Now beginning below and following the prevertebral fascia, a flap of lymph-bearing tissue is turned up so that the deep muscles of the neck will be cleanly exposed The phrenic nerve and the cervical plexus lie under the prevertebral fascia, but branches of the cervical plexus penetrate this fascia and are cut as the dissection proceeds The superior thyroid artery is doubly clamped, cut, and tied, and the muscles inserting into the hyoid bone are exposed. The hypoglossal nerve if not already identified in the suprahyoid dissection, is guarded where it makes a loop below the level of the posterior belly of the digastricus The sternocleidomastoid muscle and lymph tissue are turned upward until they can be cut away at the mastoid process and since lymph glands may be embedded in the lower part of the parotid gland, the lower pole of the parotid is resected, a few mattress sutures being inserted to hold the cut surfaces together The internal jugular vein is ligated as high as possible The wound is closed, using continuous sutures of fine catgut for the subcutaneous tissues and dermal for the skin. A soft rubber drain should be left in for forty-eight hours.

Tracheotomy

In obstruction of the air passages at the larynx, tracheotomy may be required as an emergency procedure In other cases where the obstruction is gradual in onset, the operation may be performed in a more leisurely manner and with more careful attention to the dissection.

Emergency Tracheotomy As a life saving measure it may sometimes be necessary to do the operation with little or no preparation of the skin

and with no more instruments than a knife and two hairpins The head is drawn back by placing a pillow under the neck and an incision is made in the midline 3 or 4 cm. long and centering at a point below the level of the thyroid gland, where the rings of the trachea can be felt through the skin. The incision having been made the finger is inserted into the wound to feel and steady the trachea, and one or two tracheal rings are cut. If a tracheotomy tube is not available, the hairpins may be bent to form two blunt hooks which are inserted into the trachea, pulled apart to keep the trachea open and held in that position by a string tied between them around the back of the neck In some cases it may be easier to perform the tracheotomy just below the cricoid cartilage where an uncovered area of tracheal rings exists above the thyroid gland A low tracheotomy is more desirable but in an emergency this is not of first importance.

Elective Tracheotomy A transverse incision is made the skin, subcutaneous tissue and platysma are retracted and the ribbon muscles are separated and pulled aside (Figure 21) The isthmus of the thyroid

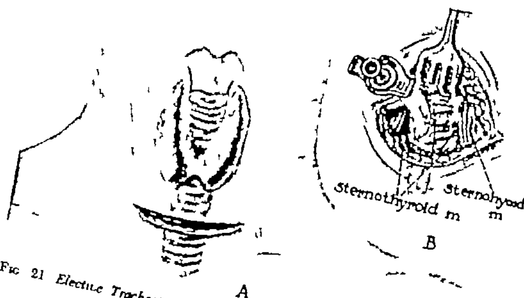


Fig 21 *Elective Tracheotomy* A Incision. B. Insertion of tracheotomy tube

gland will be exposed and the tracheotomy is usually performed below that level Any bleeding points are caught and tied, and when the field is dry two or more tracheal rings are cut in the midline and the tracheotomy tube is introduced. The ribbon muscles are brought together and a few interrupted sutures are inserted to bring the skin and subcutaneous tissue together on each side of the tube Cotton tape is tied to the tracheotomy tube and passed around the neck to hold it in place. The

section of the entire mass is continued downward until the mylohyoid and hypoglossal muscles are cleared from mandible to hyoid bone and from the posterior belly of the digastricus on one side to the same region on the other side The wound is closed by interrupted sutures of silk, and a soft rubber drain may be left in place for twenty four hours.

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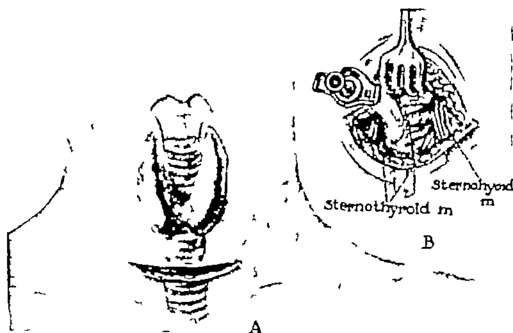


FIG 21 *Elective Tracheotomy* A. Incision. B Insertion of tracheotomy tube.

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inner tube is removed as often as necessary to keep it clean, and after two or three days the outer tube may be exchanged for a clean one as often as required.

Cervical Rib and Scalenus Anticus Syndrome

Patients with symptoms produced by pressure of the scalenus anterior muscle on the brachial plexus whether a cervical rib is present or not,

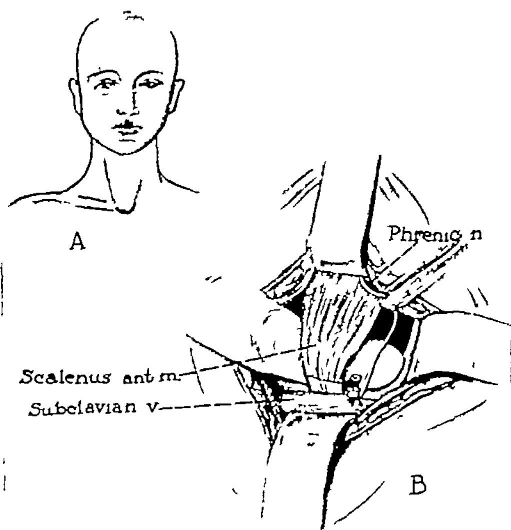


Fig 22 *Scaleniotomy* A. Incision The same incision and approach are used for crushing or avulsing the phrenic nerves B The scalenus anterior muscle is lifted up by the finger preparatory to cutting it.

are relieved by scaleniotomy A transverse incision is made one finger's breadth above the clavicle extending about 6 or 7 cm. and ending posteriorly at the external jugular vein (Figure 22A) The skin, the platysma, and the superficial layer of the cervical fascia are incised, exposing the clavicular attachment of sternocleidomastoid muscle. The muscle may

be partly divided or retracted forward After the fascia is cut through, the scalenus anterior will be seen, with the phrenic nerve running obliquely across it. The muscle is carefully separated from the under lying subclavian artery and the brachial plexus, and with the finger under the muscle (Figure 22B) it is cut near its insertion. The subcutaneous tissues are closed with catgut and the skin with silk or dermal

Phrenic Neurectomy

The approach described for scaleniotomy is the same as that used for evulsion or crushing of the phrenic nerve an operation so commonly utilized to paralyze the diaphragm. The phrenic nerve, which courses across the scalenus anterior muscle (Figure 22B) is picked up and either crushed by a hemostat or cut in two In the latter case, the lower segment of the nerve is grasped by a hemostat and slowly wound about its jaws until most of the nerve has been withdrawn from the thorax and the smaller fibers break.

Pharyngo-esophageal Diverticulum

The patient s general condition should be satisfactory before operation is considered. Dehydration and malnutrition should be corrected, and if the latter is severe a gastrostomy should be done and feeding given directly into the stomach. The diverticulum should then be excised, preferably under local anesthesia reinforced by nitrous oxide for the deeper dissection. A longitudinal incision is made on the side of the diverticulum as shown by X ray (usually the left) parallel to the anterior border of the sternocleidomastoid muscle and extending from the upper margin of the thyroid cartilage to the clavicle (Figure 23B) The sternocleidomastoid is retracted backward and the carotid artery and internal jugular vein are exposed. The omohyoid muscle is divided and the upper segment pulled up The middle and inferior thyroid vessels are clamped and divided, and the carotid artery the jugular vein, and vagus nerve are retracted backward. The sac of the diverticulum should now be exposed, coming around the lateral side of the esophagus from its origin in the posterior midline of the pharynx just above the cricopharyngeus muscle. The fundus of the sac is grasped and adhesions between the sac and surrounding tissues are carefully separated with the finger until the neck of the sac is completely freed. The neck is now clamped and ligated (Figure 23A) or if wide, it is cut off and closed in a vertical direction by two layers of interrupted sutures of silk. A drain is inserted to the region and the wound is closed as usual. In some cases, when the dissection has been prolonged and difficult, or when the patient is in poor condition, or when the sac is unusually large, it may be advisable to perform the operation in two stages, in the first stage of which the sac is freed

and anchored so that the fundus protrudes some distance outside the skin. If the sac is not long enough to do this the fundus is elevated above the level of its neck and anchored to a muscle in the region, using a silk suture the ends of which are brought out through the incision to aid later in identifying the sac. At the second stage of the operation, seven to ten days later the sac is again dissected out and cut free from the esophagus By using this principle of not removing the sac until adhesions have taken place between the wall of the sac and the surrounding tissue there is little danger of the infective esophageal con-

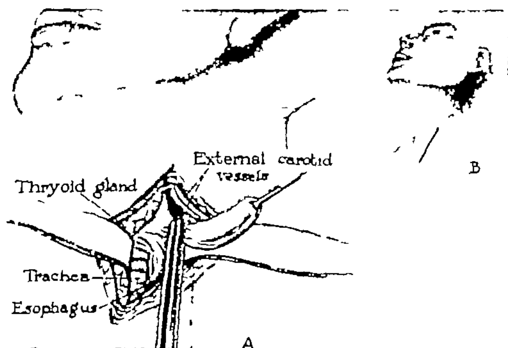


FIG. 23 *Excision of Pharyngo-Esophageal Diverticulum.* A. Clamps have been applied to the neck of the sac preparatory to excising it. B Incision.

tents getting into the structures of the neck and passing down into the mediastinum. If the sac is anchored in the upper angle of the wound it will tend to decrease in size since it is well drained, but in spite of this dissection of the sac at the second operation and identification of its neck is more difficult than at the first operation.

A Levin tube is inserted and the patient is fed through this for ten days after the operation, following which a liquid diet is permitted. The patient should be able to swallow solid food after the third week.

Tumor of the Carotid Body

Depending on the size of the tumor one may make a short transverse incision or a longitudinal incision just in front of the anterior border of the sternocleidomastoid muscle. The muscle is retracted backward and the posterior belly of the digastric muscle is pulled upward, the carotid

sheath is opened and the internal jugular vein and carotid vessels are isolated above and below the tumor so that a piece of cotton tape can be passed around them and used to control hemorrhage in an emergency (Figure 24) Injury to the vagus nerve should be avoided and the hypoglossal nerve should be guarded. If the tumor is found to be large and to have infiltrated the wall of the vein a segment of the vein may be

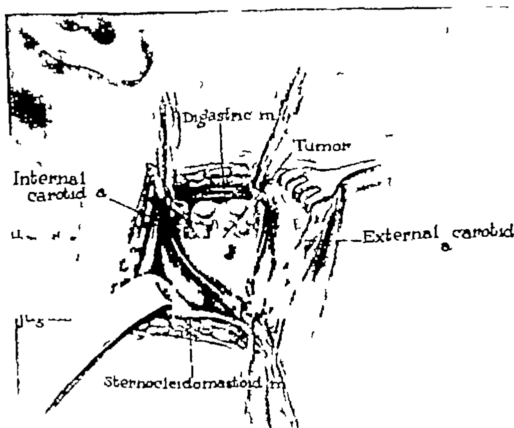


FIG. 24 *Removal of Carotid Body Tumor* Gauze tapes have been passed around the carotid vessels above and below the tumor so that hemorrhage can be controlled during the further dissection.

excised with the tumor ligating the severed ends. If the common carotid artery is similarly involved, it is wiser to partly occlude the artery with a piece of heavy silk or fascia, close the wound, and allow the cerebral circulation to adjust itself. A few weeks later the wound may be re opened and, if it is found that the patient can stand complete occlusion of the artery a segment of the artery and the tumor are removed. When there is too much infiltration of the tumor into the surrounding struc tures, a partial intracapsular removal may be done, using the electrosurgical knife When the operation is completed, the fascia and subcutaneous tissues are closed with sutures of fine catgut and the skin closed with dermal or silk.

The Thyroid Gland

Lingual Thyroid Aberrant thyroid tissue in the region of the foramen cecum should be removed if it is large enough to cause trouble and if it can be ascertained that thyroid tissue is present in the normal location in the neck. If this cannot definitely be determined, a portion of the lingual thyroid should be left in place. The tongue is pulled forward with a towel clip or traction suture, the lingual thyroid is excised by an elliptical incision and the edges of the wound are brought together by several sutures of catgut in the muscle and a few interrupted sutures of catgut in the mucous membrane.

Cyst and Fistula of the Thyroglossal Duct The cyst or fistula should be thoroughly excised and the dissection should extend back to the foramen cecum at the base of the tongue The patient is placed on the

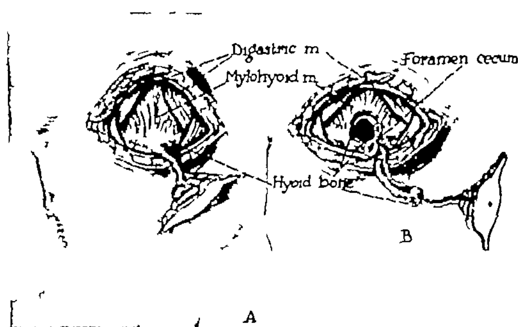


FIG. 25 *Removal of Thyroglossal Duct Fistula.* A. The tract has been dissected out down to the hyoid bone. B. The middle segment of the hyoid bone has been removed and the remainder of the tract dissected out up to and including the foramen cecum

table with the neck hyperextended and the head of the table elevated, and an incision 6 or 7 cm. long is made transversely across the neck at the level of the hyoid bone The incision extends through the skin and platysma and bifurcates around the external opening of a fistula when present The skin and platysma are reflected upward and a short distance downward and the cyst, which is located in the midline, is dissected out. When a fistulous tract is present, it is of some value to inject the tract previously with methylene blue solution. The fistulous tract, when followed inward, approaches the hyoid bone (Figure 25A) and

in some cases passes through the body of the hyoid bone, so that it is advisable to excise about 1 cm. of the bone in its middle portion (Figure 25B) Above the hyoid bone it is usually difficult or impossible to identify the tract, so that the tissue in that region is cored out up to and including the foramen cecum in order to do so it is helpful to place a finger in the mouth and push the base of the tongue upward. The wound in the tongue is sutured with catgut. The muscles of the floor of the mouth are brought together by interrupted sutures of catgut, and the two severed ends of the hyoid bone are brought together by suturing the soft tissues around them The subcutaneous tissues are closed with a continuous suture of catgut and the skin is closed with a continuous dermal suture. Because of the danger of contamination of the wound from the mouth, it is advisable to leave a small rubber drain in place for a few days.

Acute Inflammation of the Thyroid Gland In most cases inflammation of the thyroid gland subsides without suppuration but if pus does form it should be drained before extension of the infection can occur There will usually be a point of swelling and fluctuation, over which the incision can be centered and a soft-rubber drain inserted.

Chronic Thyroiditis In the case of Riedel s struma, the extreme hardness of the gland may lead one to believe that he is dealing with malignancy The struma lymphomatosa, on the other hand, may be mistaken for colloid goiter Both of these diseases are progressive in nature, and operation is indicated to relieve pressure symptoms Myxedema is common after subtotal thyroidectomy for chronic thyroiditis and care should be taken to leave a fair amount of thyroid tissue in place.

Goiter Operation should be performed in colloid goiter only when necessary to relieve symptoms of pressure or excessive deformity of the neck. In adolescent colloid goiter there is a tendency for the gland to become smaller as the patient gets older Operation should be done in all cases of exophthalmic goiter unless such complications are present that one must be content with thiouracil therapy Surgery should be performed in nodular goiter to relieve pressure symptoms and prevent or cure toxicity The possibility that malignancy may develop in nodular goiter should also be kept in mind. Because of the great tendency of symptoms to recur in exophthalmic goiter a most extensive resection of the gland is indicated in this disease. It is wise to leave in place not more than one-tenth of the glandular tissue seen in the normal person In nodular goiter the dissection need not be so extensive.

Preoperative Preparation for Operations on the Thyroid The patient suffering from hyperthyroidism requires most careful evaluation of his physical condition, with particular reference to the state of nutrition, the condition of the heart, and the basal metabolism. It is advisable in all cases to have the patient hospitalized for a considerable period before

operation is done During this time, while specific treatment is directed at improving the nutrition, treating the heart, and lowering the metabolic rate, the patient should be assured of physical and mental rest. The high carbohydrate diet that should be administered not only provides fuel for the increased metabolism but is important in the treatment of the hepatic dysfunction so commonly present. A thyroid crisis, which may develop in a few hours and which is characterized by rapid pulse and respiration elevation of temperature vomiting, diarrhea, and mental irritability that may develop into delirium, is treated symptomatically Fluid in the form of intravenous glucose should be provided in large amounts and the patient should be placed in an oxygen tent. Morphine or barbiturates or both are given as required for sedation The temperature when excessively elevated is controlled by tepid sponges. Every effort is made to avoid anything that would cause an emotional disturbance in the patient. Iodine or thiouracil should of course be administered.

Lugol's Iodine is the time tested treatment for thyrotoxic patients In the preoperative period it is given in fruit juice milk, or other drink, in a dose of 10 to 15 drops three times a day The maximum improvement from this treatment is usually secured in about ten days, although sometimes longer periods of treatment may be necessary Basal metabolic-rate determinations should be made at intervals and a study of these and of the pulse rate and general condition will indicate the optimum time for surgery If the desired effect is not obtained from iodine, thiouracil in a dose of 0 4 to 0 6 gm. daily continued over a period of from three to five weeks usually brings the basal metabolic rate to normal and relieves the toxic symptoms. After that time the dose may be reduced or the drug may even be withdrawn and the metabolism will still remain for some period at a normal level. This drug may produce dangerous toxic reactions in the form of agranulocytosis leukopenia, fever or eruption of the skin and it may affect the secretion from the anterior lobe of the pituitary with an increased exophthalmos or increase in the size of the gland. To avoid these latter effects, thyroid extract may be administered simultaneously but preferably not until the basal metabolism has been brought to normal. Because of the potential dangers of this therapy it should be reserved for those cases which are refractive to iodine.

Ligation of the Superior Thyroid Artery This operation, which at one time was often done as a preliminary to thyroidectomy is now practically obsolete The operation can be done under local anesthesia and the artery may be ligated on one or both sides An incision 3 or 4 cm. long is made transversely across the neck at the level of the upper pole of the thyroid, usually about the height of the top of the thyroid cartilage. When the operation is to be done on one side, the incision is made to start about 2 cm. from the midline and extend outward, but if both arteries are to be tied a single transverse incision in the same region on

each side and extending across the midline may be used. The skin and platysma are reflected and the fascia and muscles are separated in a longitudinal direction and retracted laterally The deep cervical fascia is incised and the surface of the thyroid gland will be seen with the vessels coming into the upper pole With the use of a curved needle and silk ligature material these vessels are ligated, turning the thyroid gland slightly to expose the posterior branches. If the superior pole cannot be well isolated, the needle may be inserted around the upper pole and all the vessels tied at once including a portion of the thyroid tissue.

Ligation of the Inferior Thyroid Artery In some cases it may be necessary to ligate both the inferior and superior thyroid vessels as a preliminary to thyroidectomy To ligate the inferior thyroid artery an incision is made about one finger's breadth above the clavicle starting at the anterior border of the sternocleidomastoid muscle and extending anteriorly about 3 or 4 cm If both the right and left inferior thyroid arteries are to be ligated the incision is extended across the midline to the opposite side the incision thus made being the same as that used in subtotal thyroidectomy at the latter operation the scar used for ligation of the vessels is excised The incision is extended through the subcutaneous tissues and platysma, and the upper and lower edges of the wound are retracted. The anterior border of the sternocleidomastoid is pulled backward and the ribbon muscles are pulled toward the midline along with the thyroid gland and the trachea, thus exposing the carotid sheath. The deep fascia is incised medial to the sheath, and the inferior thyroid artery will be seen passing to the lower pole of the thyroid gland. The vessel should be ligated by passing a needle threaded with silk around it.

Subtotal Thyroidectomy The operation is best done under local anesthesia, reinforced with nitrous oxide for the deeper dissection The patient is placed on the table on his back, with the head of the table elevated and the headrest dropped so as to hyperextend the neck. Using .5 per cent procaine hydrochloride, the skin is injected intradermally along the site of the proposed incision, which should be located one finger's breadth above the internal end of the clavicle and should extend transversely across the neck between the anterior borders of the sternocleidomastoid muscles (Figure 26) The solution is then injected subcutaneously over the anterior surface of the neck from the top of the thyroid cartilage down to the clavicle. The incision is made and deepened through the subcutaneous tissues and platysma. Bleeding vessels along the edge of the incision are caught and tied with fine catgut or fine silk. Murphy retractors are now used to hold up the upper edge of the wound, so that by combined blunt and sharp dissection a flap is turned up nearly to the top of the thyroid cartilage (Figure 27) The retractors are now shifted to the lower edge of the incision and this is freed down



FIG. 26. *Thyroidectomy* Incision.

FIG. 27 *Thyroidectomy* The flap of skin, subcutaneous tissue, and platysma are being lifted upward by gauze stripping.

to the clavicle. Towels are fastened to the upper and lower edges of the incision with clips, one of which is placed in the middle of the incision on the upper edge and one on the lower edge A self retaining retractor of the Beckman type is inserted into the wound and the edges of

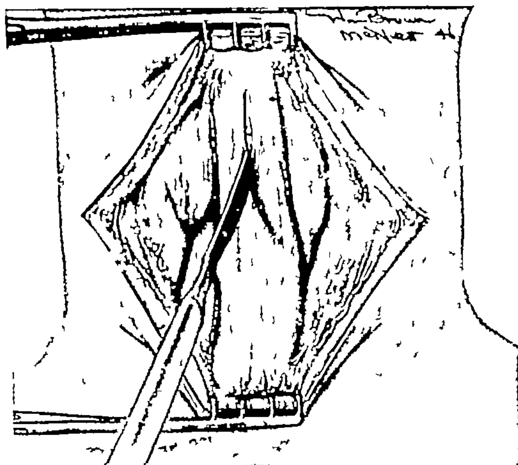


FIG. 28. *Thyroidectomy* The upper flap has been freed to above the level of the thyroid cartilage and the lower flap down to the jugular notch. An incision is being made in the midline so that the ribbon muscles can be retracted laterally

the retractor are adjusted so that they not only catch the edge of the incision but also impinge on the central towel clips. The incision is opened to its fullest extent and procaine hydrochloride is injected into the deeper tissues in the midline. The fascia is now incised longitudinally from the level of the thyroid cartilage almost down to the jugular notch (Figures 28 and 29) and the fascia and ribbon muscles are retracted to the side to be operated on, using a retractor of the U S Army style. This will expose the deep cervical fascia or so-called surgical capsule of the thyroid gland. If exposure is not adequate in the case of a large gland, the ribbon muscles may be cut transversely and at the conclusion of the operation the cut ends sutured together The deep fascia is incised and the gland, covered by its true capsule a very thin membrane is seen The right lobe

is usually the one operated on first, but a finger is inserted inside the cervical fascia, and the gland on both sides is freed enough to determine the size of both lobes The first objective is ligation of the vessels supplying the upper pole of the gland after passing a finger around the gland as

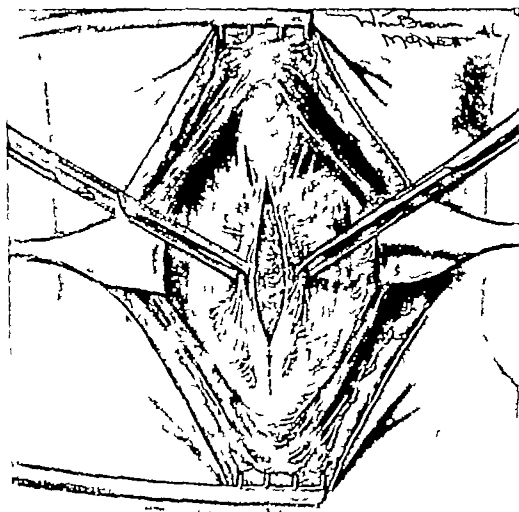


Fig. 29 *Thyroidectomy* The ribbon muscles have been grasped and are being pulled apart. The midline incision in the fascia will be prolonged downward.

well as possible and separating the upper pole from the trachea, the gland is pulled downward and the superior thyroid vessels will be seen coming in and dividing as they supply the upper pole. Clamps are applied to the vessels either just above the upper pole (Figure 30) or just below it, and the vessels and thyroid tissue, if any are cut between them and tied by a transfixion suture The gland is now pulled down and medially and, largely with finger dissection, the lateral margin of the gland is freed and the lateral thyroid veins are clamped and ligated. As the dissection proceeds downward, the inferior thyroid artery will be seen entering the gland near the junction of the middle and lower thirds (Figure 31) The

anterior branch of this vessel is clamped and ligated, and the inferior thyroid veins are similarly dealt with The finger can now be inserted under the gland which can be lifted well up into the wound. Attention is directed to the isthmus of the thyroid. The under surface of this por

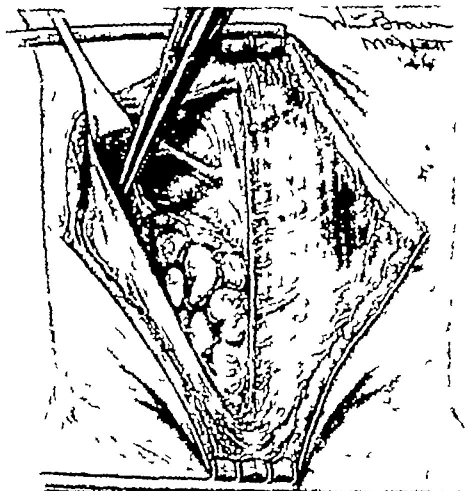


Fig. 30 *Thyroidectomy* The deep cervical fascia and ribbon muscles are retracted to one side and the superior thyroid artery has been doubly clamped.

tion of the gland is gently freed from the trachea by inserting a hemostat underneath it. When, by opening and closing the clamp sufficient space has been obtained, two Oschner hemostats are applied to the isthmus and it is cut between them (Figure 32) The isthmus is now dissected from the anterior surface of the trachea and the gland is lifted up so that it remains fixed only by the tissue at the angle between the lateral surface of the trachea and the esophagus It is here that the recurrent laryngeal nerve takes its course and in this part of the gland the parathyroid glands are commonly located. The lobe is now entirely cut off leaving only a small portion of thyroid tissue in the tracheo-esophageal angle (Figure 33) The amount of tissue left in exophthalmic goiter should not be more than one-tenth the size of a normal thyroid lobe. When the thy

roid tissue is cut through, it will be necessary to clamp a few vessels in the substance of the gland The clamped vessels are tied with fine catgut or silk, and the deep cervical fascia is sutured down over the raw sur



FIG 31 *Thyroidectomy* The upper pole of the thyroid has been mobilized. The anterior division of the inferior thyroid artery is seen entering the gland near the junction of the middle and lower thirds.

face. After the first lobe has been removed if the patient is under general anesthesia, he should be allowed to wake up and should be instructed to cough, in order to prove that the recurrent laryngeal nerve has not been injured. If he is unable to close the glottis the nerve should be dissected out and the cause of the interruption in its path should be determined. If a ligature has been inadvertently passed around it, the ligature should

be removed If the nerve has been cut, an attempt should be made to suture the ends together If one recurrent laryngeal nerve has been injured, the operation on the other side, although it may be done should

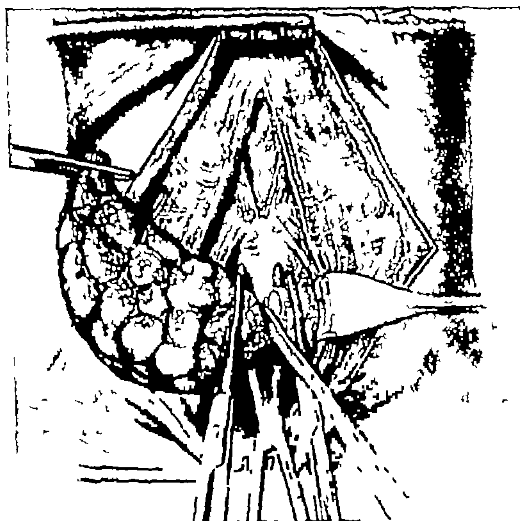


FIG. 32. *Thyroidectomy* A hemostat has been passed between the isthmus of the gland and the trachea and the isthmus is being severed between clamps.

not be extensive enough to place the remaining nerve in the slightest jeopardy

The surgeon now moves to the left side of the table, where the left lobe is dealt with in the same manner Fascia and ribbon muscles are closed in the midline by a continuous suture of fine catgut or interrupted sutures of silk (Figure 34) The retractor is removed and the transverse wound is closed by a similar suture in the subcutaneous tissue (Figure 35) Two small soft rubber drains should be inserted into the region of the thyroid stumps to take care of any oozing that may occur but if silk or cotton suture has been used throughout there is less necessity for drain-

age Drains are removed in twenty four hours The skin is closed with a continuous suture of dermal (Figure 35) In order to minimize the scar this suture is removed on the third day

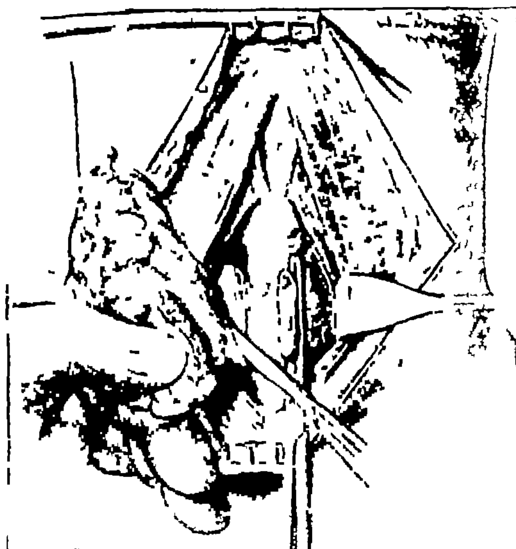


FIG. 33. *Thyroidectomy* The lobe is being removed, leaving only a small fragment of tissue in the tracheo-esophageal angle

Substernal Goiter The usual type of substernal goiter may be brought up into the neck by making gentle traction on the gland and inserting the finger down behind and around it to free adhesions If this cannot be accomplished because of the size of the gland the sternum may be dis articulated from the clavicle to give more room or as Lahey suggests, a partial intracapsular removal of the gland may be done to reduce its size so that it can be pulled up

Adenoma of the Thyroid Gland A single encapsulated tumor may be removed without sacrificing any of the thyroid tissue The usual approach to the thyroid gland is made, the lobe of the gland in which the tumor is

FIG. 34. *Thyroidectomy* The ribbon muscles are being brought together in the midline.

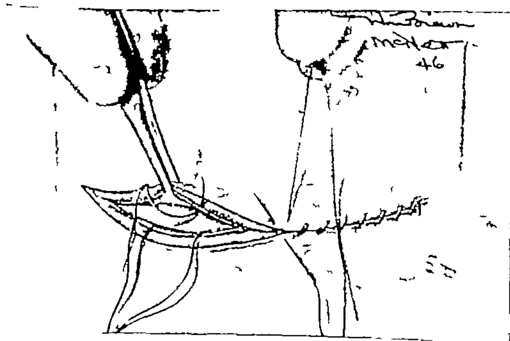


FIG 35 *Thyroidectomy* The subcutaneous tissues are being closed with a continuous suture of catgut and the skin is being closed with dermal.

located is exposed, and an incision is made down to the tumor It is grasped with forceps pulled upward, and any vessels supplying it are ligated. The usual closure used in thyroidectomy is then done.

Postoperative Treatment following Thyroidectomy When returned to bed the patient is placed in a semi sitting position and an intravenous injection of 10 per cent glucose is started. Morphine is given for restlessness, and if there is evidence of cyanosis oxygen is administered. Fluids may be taken in small amounts as soon as nausea has subsided. Lugol's solution may be given by rectum until the patient is able to take it by mouth, but the drug usually is not necessary

Hemorrhage is a most serious complication following thyroidectomy Unless the blood is able to escape from the wound, it may cause obstruction of the trachea by pressure, and immediate treatment may be necessary to save the patient's life. Bleeding from the skin edges is not of great consequence and can be controlled by inserting a mattress stitch around the bleeding point. Venous bleeding may occur under the skin flaps but, although there will be a great deal of bulging of the flaps it is not so apt to be associated with respiratory embarrassment. One or two of the skin sutures may be removed and the clot evacuated, pressure applied by a bulky dressing is usually sufficient to control it. Hemorrhage into the confined space behind the ribbon muscles whether it is arterial or venous in origin, should cause the greatest concern. The sutures in the skin should be immediately cut, the flaps elevated, and the ribbon muscles separated by cutting the sutures holding them together This should permit the blood to escape to the outside and relieve the tracheal pressure while the patient is being transported to the operating room to find and control the source of bleeding With an adequate airway a gas anesthetic may be administered while the field is cleared and the bleeding vessel identified and ligated. Arterial blood will come from the superior or inferior thyroid artery of one side venous blood is most apt to arise from one of the lateral veins. The bleeding having been controlled, a soft rubber drain is inserted and the wound closed as before. Occasionally emergency tracheotomy is required in these patients.

Injury of a recurrent laryngeal nerve is not uncommon during thyroidectomy and may not be due to actual section or ligation of the nerve but merely to manipulation of it, swelling of the tissues in the immediate neighborhood of the nerve may affect it within a short time after the operation. The only evidence of unilateral nerve paralysis may be inability to cough and some hoarseness but if both nerves are paralyzed respiratory difficulty may develop The cords should be examined and if paralysis is present the patient should be kept under careful observation, with an emergency tracheotomy set ready for instant use When the paralysis is due to pressure or mild trauma recovery should take place.

Obstruction of the trachea, sometimes called collapse of the trachea,

may follow the removal of a large goiter The theory is that the gland growing closely around the trachea not only has weakened its wall but at the same time by adhering to it, has furnished support to the weakened wall with the removal of the support the trachea may collapse. Whether or not this actually occurs there is no question that partial obstruction of the trachea may take place and may be due partly to tracheitis and partly to tight sutures in addition to the process mentioned above Dyspnea and cyanosis may appear and emergency tracheotomy may be necessary Lesser degrees of obstruction may be relieved by oxygen and tracheitis may be improved by steam inhalations

Thyroid crisis, which resembles the crisis that may occur preoperatively but is apt to be more severe is seen most often from six to twelve hours after operation. The treatment of the condition is the same as that already outlined under preoperative management

Parathyroid tetany resulting from accidental removal of the parathyroid glands or injury to the glands either during the operation or due to swelling after the operation usually begins with stiffness of the hands and spastic contractures of the fingers and the toes. There is irritability of the motor nerves, as shown by Chvostek s sign, and increased irritability to electrical stimulation as shown by Erb s sign. (Chvostek s sign is a spasmodic contracture of the muscles of the face elicited by percussing the trunk of the facial nerve in front of the ear) Rapid respiration, laryngeal spasm, and convulsions may occur Characteristic of the condition is a lowered serum calcium and elevated serum phosphorus The serum calcium, which normally is between 10 and 12 mm., may drop to 6 mm. or lower with symptoms of tetany usually appearing when the level is about 8 mm. The condition is treated by the intravenous injection of 5 cc. of 10 per cent solution of calcium chloride in normal saline solution and calcium lactate in dosages of 10 to 25 gm. is given daily by mouth. To assist in the utilization of the calcium, viosterol is given orally each day If the symptoms are not controlled by these measures, parathyroid extract solution is given daily or oftener by intramuscular injection in a dose from 15 to 50 units In most cases the symptoms of parathyroid deficiency gradually disappear but serum calcium determinations should be made at intervals during convalescence and after the patient leaves the hospital, and he should continue to take calcium and viosterol until he has made a complete recovery

The patient is usually allowed out of bed on the fourth day after operation and dismissed from the hospital on the sixth day but when complicating diseases, such as cardiac decompensation or diabetes, are present convalescence is prolonged.

Carcinoma of the Thyroid Gland When the mass is obviously fixed to surrounding structures and when the cervical glands show evidence of metastasis, the case may be considered inoperable. If the disease has not

progressed to this extent, an operation should be performed and an attempt made to remove the diseased thyroid tissue which in many cases will amount to doing a total thyroidectomy One must, however be sure to leave the posterior capsule to protect the parathyroids and the recurrent laryngeal nerves. In many cases at operation, one may not suspect that one is dealing with malignancy as the condition may resemble an ordinary nodular goiter If the question of malignancy does arise a frozen section should be made if carcinoma is found a radical operation should be done. In occasional cases there may be a nodule that is definitely circumscribed, which is found to be malignant. In such a case complete removal of the nodule with liberal sacrifice of the surrounding thyroid tissue should be done

In performing total thyroidectomy the technique in general is the same as that described under subtotal thyroidectomy The vessels at the upper pole are cut and ligated, the lateral veins are cut and tied, and the entire lobe is mobilized medially If there is any adherence of the tumor to the ribbon muscles as much as necessary of the muscles should be removed along with the gland. The lobe is pulled over toward the midline until the trachea can be seen behind it, vessels clamped as necessary and the recurrent laryngeal nerve identified where it passes through the bifurcation of the inferior thyroid artery The arterial branches are cut and the nerve is allowed to drop back into the tracheo-esophageal groove. The gland is carefully separated upward, with the nerve in sight at all times, until it has been freed from the trachea. The pyramidal lobe when present is separated in the midline, and the isthmus is rolled laterally as it is removed from the trachea. The surgeon then moves to the other side and a similar procedure is followed until the gland has been entirely freed. If at any time it is found that the gland cannot be removed because of extension of the carcinoma, the operation must be concluded and X-ray therapy given or radium emanation seeds implanted. The parathyroid glands should be watched for they will appear as small brownish or pinkish flattened nodules When they are encountered they should be carefully avoided, and if any are found to have been removed when the thyroid is inspected they should be placed back in the sternocleidomastoideus, where they may grow as transplants Hemostasis having been obtained, the ribbon muscles are closed and the operation concluded as in subtotal thyroidectomy

Postoperatively paralysis of both recurrent laryngeal nerves is common, but if the nerves have been carefully guarded the paralysis should be temporary If parathyroid tetany develops it is treated as outlined under the postoperative treatment of the thyroidectomy patient The symptoms of myxedema appear about two months after total thyroidectomy but usually a small daily dose of thyroid extract (015 gm.) is sufficient to relieve the symptoms.

The Parathyroid Gland

A tumor of a parathyroid gland should be removed The thyroid gland is exposed by the usual technique the lateral veins are caught and ligated, and the gland is turned inward branches of the inferior thyroid artery being ligated as required The gland is lifted up and the region near the tracheo-esophageal groove is inspected and palpated The finger should also be passed down into the superior mediastinum along the trachea and esophagus to search for a tumor mass If the tumor is not found on one side the other side should be similarly investigated A tumor once found should not be removed until the presence of a normal parathyroid gland can be demonstrated If a nodule is found to be present in the thyroid tissue and no other tumor can be found a subtotal resection of the lobe of the thyroid may be done, since a parathyroid gland is sometimes in the substance of the thyroid If a tumor is found it should be enucleated and the vessels supplying it should be caught and tied A tumor in the superior mediastinum can usually be pulled up into the neck for removal The recurrent laryngeal nerves, lying as they do in close proximity to the parathyroid glands should be carefully guarded. Particular care should be used in ligating the inferior thyroid artery since the nerve may pass between its branches. It should be borne in mind that tumors of the parathyroid glands are occasionally multiple and if one is found search should be made for another

CHAPTER VII

The Mammary Gland

The Mammary Gland

PREOPERATIVE PREPARATION

The axilla and the upper part of the arm, the chest wall, and upper abdomen are shaved. If there is a possibility of malignancy an X ray of the chest is taken.

LESIONS OF THE MAMMARY GLAND

Congenital Anomalies

A very common anomaly is the presence of one or more accessory nipples which are seen both in the male and in the female. The nipples, which appear as small slightly elevated pigmented papules occur in the milk line that extends from the anterior axillary line to the inguinal fold, and only rarely is there any breast tissue associated with them. Aberrant breast tissue is however not infrequently seen just above and lateral to the mammary gland and during lactation it undergoes the usual enlargement. It is not provided with a separate nipple

Another common abnormality of the breast, which is probably congenital in origin, is inverted nipple. Other less common minor conditions are the split and the flat nipple.

Congenital absence of the breast may be seen in association with absence of the pectoral muscles and may be unilateral or bilateral Complete absence of the breast may also be encountered when there is a congenital absence of sweat glands in the skin. The nipple only may be absent, with the breast tissue normal but this is a rare anomaly

Abnormal Enlargement of the Breast

Gynecomastia This term is applied to an enlargement of the male breast due to proliferation of the ducts and connective tissue The condition may affect one or both breasts and cystic changes may take place similar to those in cystic disease of the breast. Bilateral gynecomastia is sometimes caused by a hormonal disturbance associated with teratoma of the testicle and this fact should always be kept in mind.

Virginal Hypertrophy Enlargement of the breast in the female may progress to such a degree that it produces great deformity and even physical disability The condition like gynecomastia and fibroadenoma is due to excessive hormonal stimulation.

Inflammation

Acute Mastitis Infection of the breast usually by the staphylococcus is most common during lactation but may take place at any time The usual symptoms of inflammation appear and if the infection does not subside an abscess may form The breast becomes firm painful, and congested, and as suppuration develops an area of softening appears The condition is usually confined to one segment of the breast but if not properly treated the wall of the abscess may perforate and with burrowing of the infection, a series of pockets is formed The usual breast abscess is located in the breast tissue but subcutaneous and retromammary abscesses may occur the latter usually as an extension from the primary infection in the breast itself

Chronic Mastitis Injury with hemorrhage into breast tissue particularly when the breast is fatty may cause a localized fat necrosis fibrous proliferation, and lymphocytic infiltration. Cysts may develop and, with contraction of the fibrous tissue a hard mass is formed in which there may be calcium deposits The lump in the breast may closely resemble carcinoma, because it may become attached to the skin or pectoral muscle and may cause retraction of the nipple There is no pain after the immediate symptoms of the injury have disappeared

In other cases, a similar but more diffuse process may occur in the breast as a result of injury or as a chronic inflammatory condition The breast may become shotty and fibrotic and small areas of calcification may be distributed throughout.

Tuberculosis The presence of one or more sinus tracts associated with induration of a portion of the breast and intermittent discharge of pus suggests that the cause of the infection is the tubercle bacillus. An attempt should be made to find the causative organisms in the pus and search should be made for tuberculosis elsewhere. The condition may be primary in the breast but is probably more often secondary to pulmonary tuberculosis with involvement of the ribs or sternum. Tuberculosis of the axillary glands may represent extension of the infection from the breast, or according to some authorities, the axillary glands are involved in a retrograde fashion from the chest, and the breast infection is secondary

Syphilis Chancre of the nipple is not rare and the skin of the breast may of course partake in the general eruption of secondary syphilis. Gumma of the breast is a very rare lesion and usually requires biopsy for diagnosis.

Cystic Disease of the Breast

This condition, which is also known as chronic cystic mastitis and which has been described under a number of other names, derives its greatest importance from the fact that it is characterized by the development in the breast of lumps that may mask or may be difficult to tell from carcinoma. In the typical case of cystic disease, both breasts have a shotty feeling and there may be one or more fairly large indurated areas sometimes involving an entire quadrant. The indurated portion is tender and usually it is pain in it that brings the patient to the doctor The patient may feel one lump in the breast but examination usually reveals several of them — all of them indefinitely defined and not attached to the skin or chest wall, as a malignant tumor may be and yet not gliding out from under the fingers as does a fibroadenoma. Cystic disease of the breast is common in women in the thirties and forties, but is less often seen in older women. Bleeding from the nipple may occur but it is a rare symptom.

When one of the indurated regions is incised it is found to be tougher than the normal breast tissue, with which it merges imperceptibly but it does not have the hardness of scirrhus carcinoma. The involved region is yellowish white in color and scattered throughout are usually many cysts, which vary in size from the head of a pin to 1 or 2 cm. Very large cysts the so-called blue-domed cysts are not seen so often at the present time but were emphasized by the older writers. The "blue dome effect is the result of the clear fluid contents viewed through a thin layer of whitish breast tissue In *some cases such a cyst may contain* milky fluid. This is not actually milk but cloudy serous fluid. In other instances the fluid may be brownish, from the presence of old blood.

Galactocele

This is a cyst that occurs during the nursing period and is due to obstruction of a duct. Frequently such a cyst will drain spontaneously through the nipple but occasionally the mass persists and must be excised Usually in these cases the milk is found to have solidified to a caseous mass that resembles the contents of a sebaceous cyst.

Benign Tumors of the Breast

Fibroadenoma There are three tumors belonging in this classification, simple fibroadenoma, intracanalicular fibroadenoma, and pericanalicular fibroadenoma, but they are so closely related that one type of tumor may show the characteristic structure of another All are benign, definitely encapsulated and rounded in shape or slightly nodular They cause no pain but may grow to large size *Although the tumor is usually single,* two or more tumors in one or both breasts may be encountered. The growth is most often seen in young women and its development is rare

after the menopause. A fibroadenoma causes no dimpling of the skin since it is not attached to the fibrous strands of the breast nor does it become fixed to the retromammary tissue The characteristic feature of the tumor is the way it tends to roll and slip away from the examining finger when pressure is made on it. When the tumor is sectioned it offers considerable resistance to the knife and is whitish in color and sharply demarcated from the surrounding breast tissue The difference in the forms of fibroadenoma is seen under the microscope In the intracanalicular variety connective tissue has proliferated extensively and is seen to project into the ducts in such a way as to produce flattening and distortion of the ducts The pericanalicular type shows over-growth of both the glandular and connective tissue elements but the latter predominate. In the simple fibroadenoma there is more or less equal proliferation of the glandular and fibrous structures, with dilated ducts evenly distributed throughout the connective tissue stroma.

Adenoma This is a rare tumor which is encapsulated, firm, rounded, and yellowish brown in color It may be found in any part of the breast and microscopically shows a highly differentiated appearance, which may duplicate normal breast tissue. Another type of adenoma, which grossly resembles the above, is termed fetal adenoma because of its microscopic similarity to fetal adenoma of the thyroid.

Sarcoma Phyllodes Cysticum In spite of its formidable name, this tumor does not metastasize and seldom recurs after removal. It causes a smooth rounded enlargement of the entire breast, which may reach enormous proportions. On section it is grayish in color lobulated, and shows many small cysts that contain mucoid or brownish fluid. Microscopically it resembles intracanalicular fibroadenoma, but the stroma consists largely of poorly differentiated spindle cells sarcomatous in appearance.

Duct Papilloma This tumor is a wart like growth that develops in a dilated duct near the nipple and may be palpable as a small, firm, rounded, non tender mass The tumor grows slowly but apparently may become malignant, the main symptom of both the benign and malignant forms being bloody or sometimes serous discharge from the nipple. Occasionally a papilloma may develop in a cyst and appear as a small warty projection from the cyst wall and its presence may not be suspected until the cyst is removed and opened. Multiple duct papillomata in one or both breasts may be encountered.

Other Benign Tumors Lipoma, myxoma, and chondroma may occur in the breast, but these tumors are rarely encountered.

Malignant Tumors of the Breast

Scirrhus Carcinoma The tumor is palpable as a firm, indefinitely defined nodule, associated with which there may be demonstrable dim

pling of the skin and flattening of the breast in that region Owing to deep fascial attachment, the tumor may not be freely movable on the pectoral muscle In the later stages, ulceration of the skin with growth of the tumor outward, or fixation of the tumor to the chest wall may take place. Metastasis may cause enlargement of the axillary subclavian, or supraclavicular glands. Extension to the pleural cavity may take place through lymph vessels that pierce the intercostal muscles, and the peri toneal cavity may be invaded by extension of the carcinoma cells along the rectus sheath and the lymphatic plexus in the linea alba to the subperitoneal lymphatics The liver may be involved by extension of the process through the lymphatics of the falciform ligament to the portal lymphatics. Distant organs particularly the bones, may be the site of metastasis when the tumor spreads by way of the blood stream.

The gross appearance of scirrhus carcinoma of the breast is so char acteristic that as soon as it is sectioned the nature of the tumor can usually be recognized at a glance. It is not surrounded by a capsule and its margin is obscured by radiating processes, which extend into the breast tissue. It is firm to the knife and the cut surface is slightly grayish in color with white striations and occasional yellowish minute spots and lines. When pressed with the finger the tumor has about the same consistency as a raw potato

Carcinoma Simplex In gross appearance this tumor resembles scirrhus carcinoma, but microscopically there is less fibrous tissue and the epithelial element consists of irregularly oval cells distributed in small patches and cords throughout the stroma.

Medullary Carcinoma In this type of tumor the glandular element predominates greatly over the connective tissue element, and the tumor is soft and friable and rapidly growing With ulceration through the skin it may form a foul, fungating mass.

A diffuse form of medullary carcinoma, which may develop during lactation and in which the tumor is soft and rapidly disseminating, is known as acute carcinoma. The reddened and swollen breast in this con dition may be mistaken for acute mastitis

Adenocarcinoma This type of carcinoma is less common and is of a low grade of malignancy A large mass usually forms in the breast and the tumor is soft, but metastasis to the axillary glands occurs late if at all.

Duct Carcinoma The common form of this disease is a papillary growth that develops in one of the ducts near the nipple. Attention is usually called to it only by the occurrence of bleeding from the nipple.

Intraduct carcinoma or comedocarcinoma is characterized by the growth of tumor cells in several of the smaller ducts with eventual invasion of the surrounding breast tissue. This tumor may resemble in gross appearance cystic disease of the breast, although cysts when present are usually small When pressure is made on the tumor worm-like casts

of the ducts can be expressed Duct carcinoma is of low grade malig nancy but metastasis to the regional glands may occur late in the disease

Paget's Disease of the Nipple: This disease begins as a chronic eczematoid lesion of the skin in the region of the nipple. Microscopic section of the skin shows, in addition to hypertrophy of the epidermis and round and plasma-cell infiltration of the dermis, characteristic large vacuolated cells known as Paget cells in the epidermis. Usually within two years after the onset of the skin disease a carcinoma develops in the breast, not necessarily in the region of the nipple but often in the periphery of the gland The exact relation between the skin lesion and the breast tumor is not understood.

Sarcoma of the Breast This is a comparatively rare disease but may be seen, particularly as a result of malignant change in an adenofibroma. The tumor grows rapidly and produces great enlargement of the breast. Metastasis to the regional glands is less common than in carcinoma, but secondary lesions may develop in the lungs, liver or other internal organs.

TREATMENT

Congenital Anomalies

Surgical treatment is seldom required for congenital abnormalities of the breast. Aberrant breast tissue may be removed if it causes symptoms, and an inverted nipple in a woman of the child-bearing age may be corrected by a simple plastic procedure.

Abnormal Enlargement of the Breast

Gynecomastia This tends to disappear spontaneously If the enlargement of the breast is extreme and has been present for some time, the breast tissue may be removed and the nipple left in place The testicles should always be examined to be sure that no tumor is present.

Virginal Hypertrophy Most cases are treated satisfactorily by a properly fitting support, but in extreme cases simple amputation of the breast may be necessary The breast tissue may be partly or completely removed and operations have been described by which the nipple and areola are transplanted to a higher location on the partially amputated breast.

Inflammation

Acute Mastitis During the period of acute inflammation, the breast should be treated by heat and support. When an abscess forms it should be drained. Penicillin should be administered.

Chronic Mastitis A localized area of chronic inflammation, such as occurs with traumatic fat necrosis, is cured by local excision of the in

durated mass. Diffuse mastitis is not a surgical condition unless it is associated with intractable pain or unless the problem of differentiating a certain area from carcinoma should arise. In those circumstances removal of the mass in question should be performed, or in older women a simple mastectomy may be justifiable. If carcinoma is found, a radical operation should be done.

Tuberculosis Simple amputation of the breast is necessary and if there is evidence of tuberculosis elsewhere the patient should have the usual systemic care. If the axillary glands are involved they may be removed with the breast, but when the infection involves the ribs or sternum, mastectomy is useless

Syphilis Antisyphilitic treatment is indicated if a lump is palpable in the breast and a strong possibility exists that it may be a gumma. If the mass does not rapidly subside it should be removed for microscopic examination.

Cystic Disease of the Breast

Cystic disease of the breast causes little disability and tends to subside or cease progressing after the menopause Unless large cysts are present surgery is seldom indicated for this disease itself The large cysts can be excised, and only in rare instances are the breasts so painful as to warrant simple mastectomy On the other hand even when the breast is known to be the seat of cystic disease, a single firm lump must always be viewed with concern because of the possibility that it may be carcinoma, and excision of the mass is indicated. If examination shows that the lump is carcinoma, a radical amputation should be done at once. When multiple firm lumps are present in both breasts, it is impractical to excise all of them and one naturally hesitates to advise the mutilating operation of amputation of both breasts Thus it is necessary to have the patient return at frequent intervals for examination and if one of the masses shows a different course or consistency at any time it should be excised for examination. This program places a great responsibility on the surgeon and depends on the co-operation of the patient. I recall one patient who was found to have multiple masses in both breasts all of which seemed to be of the same nature I told her to come back for examination monthly but she came back for the first time about six months later with a large carcinoma and axillary metastasis

Benign Tumors of the Breast

Fibroadenoma Although these tumors grow slowly and do not become malignant, they should be removed

Adenoma Removal of the tumor is indicated

Sarcoma Phyllodes Cysticum Simple amputation of the breast should be done

Duct Papilloma When a tumor is palpable it should be removed. This subject is discussed under Bleeding from the Nipple

Malignant Tumors of the Breast

Scirrhus and Medullary Carcinoma and Carcinoma Simplex If no distant metastases are present, if the tumor is not widely fixed to the chest wall, and if ulceration of the axillary glands or edema of the arm is not present, the treatment consists of radical amputation of the breast. When the tumor is not large it is completely removed through a radial incision and examination of a frozen section is made before the radical operation is begun. If a large tumor is present, a small portion of the tumor should be excised for examination The instruments used in removing the section should not be used again in the later operation, the surgeon s gloves should be changed and the wound should be closed so that there will be no danger of implanting cancer cells in the amputation wound If the cancer has ulcerated through the skin the raw surface should be carefully covered with towels to prevent infection of the wound. In some cases when there is massive involvement of the axillary glands and the percentage of cures is low simple amputation to eliminate the foul smelling mass of the tumor may be advisable unless the growth has extended into the pectoral muscles, when they too must be sacrificed. In many of these advanced cases radiation offers as much as surgery Radiation should be given also to all cases after operation has been performed. In carcinoma of the breast with metastasis to the bones or elsewhere the prognosis is of course hopeless, but radiation therapy may be used on the breast and over the bones to control the pain.

Adenocarcinoma Radical amputation of the breast is indicated.

Duct Carcinoma A tumor palpable near the nipple should be removed and subjected to immediate microscopic examination If it is found to be malignant, radical amputation of the breast should be done.

In the case of comedocarcinoma, radical amputation should be performed, since this tumor also may metastasize to the axillary glands.

Paget's Disease of the Nipple This condition should be treated by radical amputation of the breast. Biopsy of the skin may be necessary to make the diagnosis when no tumor is present.

Sarcoma of the Breast Radical amputation is the proper treatment for this tumor

Bleeding from the Nipple

Passage of blood from the nipple is usually due to a duct papilloma, either benign or malignant, located near the nipple in one of the larger ducts. A tumor in this location is palpable if it is of any size Other lesions that may cause bleeding from the nipple are cystic disease of the breast,

simple inflammation of the duct, and carcinoma of the breast, but these conditions are responsible for bleeding only rarely and it must be confessed that in some cases the cause of the bleeding is unknown. If a palpable tumor is present in the region of the nipple, it should be removed and examined microscopically If the tumor is benign nothing more need be done but if it is malignant, a radical amputation of the breast should be performed. If no tumor is present in the nipple region, and the patient has cystic disease of the breast and no tumors other than the usual small shotty nodules are palpable, the patient may be kept under careful frequent observation and no operation performed unless a tumor becomes evident. In the older woman to whom the loss of the breast may not be so distressing, a simple amputation may be done, preceded, however by an incision in the region of the nipple to search for a duct papilloma. If carcinoma is found, the pectoral muscles and axillary glands should be removed. When cystic disease of the breast is present with multiple, fairly large indurated areas a program of simple observation entails a great deal of responsibility on the part of the surgeon and must have the conscientious co-operation of the patient.

Bleeding from the nipple and the presence of a single nodule in the breast calls for the removal and examination of the nodule. If it proves to be a benign tumor or cystic disease continued observation of the patient is indicated, and if it is malignant a radical amputation should be performed.

In occasional cases in which the amount of bleeding may be so great as to be distressing to the patient, simple amputation must be carried out if examination of the region of the larger ducts reveals no tumors.

In summary bleeding from the nipple in the absence of a tumor calls for observation rather than surgery unless the bleeding is profuse and frequent. If it is due to a duct papilloma it is reasonably safe to wait until the tumor becomes palpable if it is due to cystic disease, although there is more justification for removal of the breast, the operation is not imperative. Bleeding from the nipple plus a tumor in the breast calls for immediate removal of the tumor and radical amputation if it is found to be malignant.

TECHNIQUE

Inverted Nipple

A semilunar segment of skin is excised on each side of the nipple and when the incisions are closed the nipple will be brought into prominence (Figure 36C)

Drainage of Breast Abscess

An incision is made over the fluctuating area in a radial direction from the nipple (Figure 36F) After entering the abscess the cavity should

be explored to be sure that all connecting cavities are freely opened A Penrose drain is inserted and sutures are usually not necessary In many cases counter-drainage is advisable. This is accomplished by mak



FIG. 36. A. Incision for simple mastectomy B A circumareolar incision for removal of a tumor in the larger ducts C. Operation for inverted nipple D Submammary incision for removing tumors in the lower half of the breast. E Vertical incision that may be used for simple amputation of the breast. F Radiating incision used for removal of a tumor or drainage of an abscess.

ing another incision at the periphery of the breast and establishing through and through drainage with a soft rubber tube. Penicillin therapy should be used

Removal of Benign Tumor

The tumor is located in the breast and held in a fixed position by the thumb and forefinger while an incision is made through the skin over it. The incision is made in a direction radiating out from the nipple and should be about equal in length to the diameter of the tumor If the tumor is fairly large and situated in the lower half of the breast, an incision may be made in the inframammary line and the breast dissected up off the pectoral muscle so that the mass can be approached from the rear (Figure 36D) This incision leaves an inconspicuous scar but is not applicable in most cases. If the radial incision is used, Murphy retractors are inserted in the incision and the wound is deepened through the breast tissue down to the tumor The tumor is grasped with a hemostat and, by the use of curved scissors and traction on the hemostat, the tumor is quickly cut out of the gland. The bleeding vessels are caught and tied, and the breast tissue is brought together by a few sutures of catgut. The skin is closed with dermal. Because of the tendency of serum to collect in the tissues, it is advisable in many cases, particularly when

the inframammary incision is used, to leave a small Penrose drain in place for twenty four hours

Removal of Duct Papilloma

A radial incision close to the nipple or a curved incision following the edge of the areola may be used (Figure 36B) The skin edges are grasped with Allis forceps and retracted, and the tumor is located by palpation. A hemostat is applied to it and it is cut out with scissors, protecting the neighboring ducts as carefully as possible. Bleeding vessels are caught and tied and the skin is closed with dermal.

Simple Amputation of the Breast

An elliptical incision is made with its long axis parallel to the body (Figure 36E) and with its two limbs sufficiently far apart so that when the wound is closed the skin will come smoothly together without tension. In planning the incision it is helpful to lift the breast up in the fingers and mark the skin at the appropriate points with the back of the knife The incision is deepened into the subcutaneous fat on the medial or lateral side Murphy retractors are inserted, and the skin and fat are dissected back to the margin of the breast tissue. After this the same procedure is done on the other side The breast tissue is then lifted up and dissection is continued inward until the fascia overlying the pectoralis major is encountered while tension is kept on the breast, the separation is continued in this plane until the entire gland has been freed. Bleeding vessels are caught and tied during the course of the operation, and the skin is closed by several interrupted sutures of silkworm gut and a continuous suture of dermal. A Penrose drain is inserted in the wound and should be removed twenty four hours later When it is desired to retain the nipple for cosmetic reasons, an incision may be made in the inframammary fold, the skin and subcutaneous fat dissected upward, and the breast tissue removed from below upward.

Radical Amputation of the Breast

The patient is placed on the table with the arm abducted on an arm board. After the application of antiseptic to the field, drapes are applied. The incision which I use in practically all cases is that of Willy Meyer (Figure 37) This is an elliptical incision that starts high up on the anterior axillary fold, passes downward and divides to encircle the breast, and meets again over the upper part of the anterior rectus sheath just lateral to the midline. In rare instances when the tumor is located in the extreme outer or inner portion of the breast, the transverse incision of Stewart is used, but this does not give as satisfactory access to the axilla. The incision must be so planned as to remove the tumor and a wide margin of normal skin around it. In most cases it is possible

to close the incision after the operation but if necessary one should not hesitate to sacrifice so much skin that the wound must be left partly open because immediate skin grafts can be applied To plan the incision the breast should be lifted up with the fingers and with the use of the back

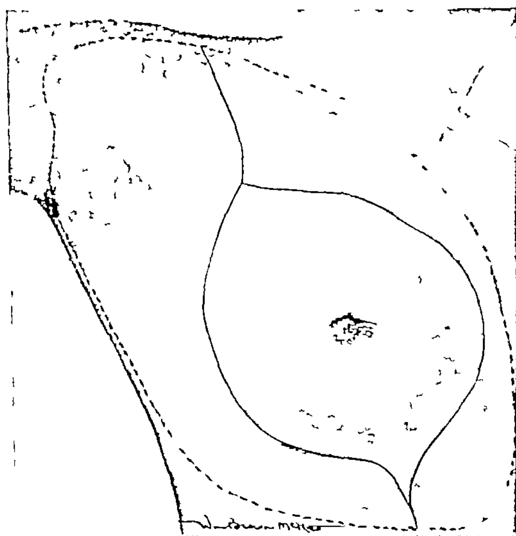


FIG. 37 *Radical Amputation of the Breast* Incision.

of the knife preliminary marks made until the location is satisfactory The surgeon stands on the side on which the operation is to be per formed, and the medial limb of the incision is cut through the skin and subcutaneous fat. The first assistant, who stands on the opposite side of the table, inserts two Murphy retractors and lifts the skin and subcutaneous fat up vertically while the surgeon cuts it loose. Vessels are clamped as they are encountered, and the flap is dissected to the middle of the sternum. A hot moist pack is placed under the flap and the as sistant takes another moist pack in his hand and pulls the breast medially The lateral limb of the incision is now cut. The second assistant inserts

a Murphy retractor in the lateral margin of the incision, the surgeon holds a similar retractor in his left hand, and, as the retractors pull the skin outward, the flap is dissected back past the axillary vessels to the edge of the latissimus dorsi (Figure 38) The tendon of the pectoralis

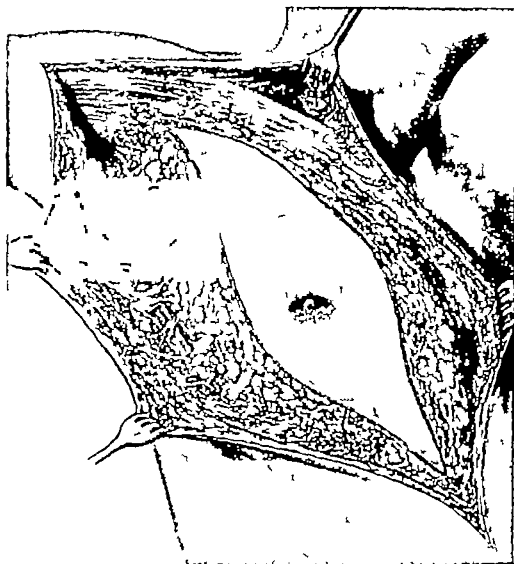


FIG 38 *Radical Amputation of the Breast.* The anterior flap has been dissected forward to the midline of the sternum and the posterior flap backward to the anterior margin of the latissimus dorsi

major is freed, a finger is inserted under it (Figure 39) and it is cut off close to its humeral attachment, grasped with a hemostat, and pulled medially It will be noted that the fibers of the pectoralis major are separated from those of the deltoid by the cephalic vein A finger is next inserted under the tendon of the pectoralis minor which is cut between two heavy hemostats (Figure 40) close to its insertion. A suture ligature is applied to the distal stump and tightened and tied as the clamp is

removed. The pectoral muscles are pulled medialward, the pectoralis major is cut loose from its clavicular attachment, and the fat and fascia covering the axillary vessels are exposed. The coracoclavicular fascia is incised, and, beginning at the outer and upper margin of the axilla all fat, fascia, and lymph glands are dissected from the axillary vessels and nerves by the judicious use of knife and scissors and by gauze stripping

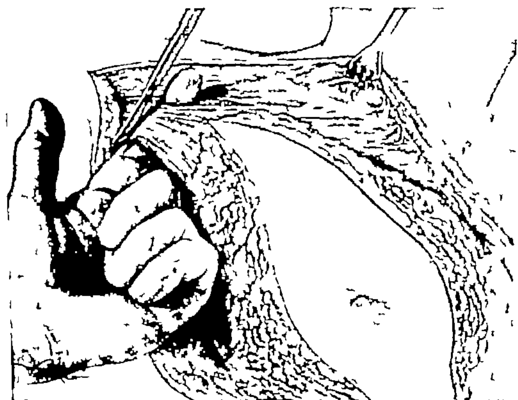


FIG. 39 *Radical Amputation of the Breast* The tendon of the pectoralis major is being divided. The cephalic vein separates the pectoralis major from the deltoid.

(Figure 41) The fascia covering the axillary vein is incised longitudinally with scissors, and, with the surgeon always working downward and inward, the subscapular lateral thoracic, and thoraco-acromial branches of the axillary vein and artery are doubly clamped, cut, and ligated as they are encountered, and the dissection is continued to the chest wall. Lymph glands lying under the axillary vessels are removed, with great care to protect especially the thin walled vein. The glands are distributed in a lateral group medial and posterior to the vein, a pectoral group along the lower margin of the pectoralis minor a subscapular group along the course of the subscapular artery an intermediate group near the base of the axilla, and a subclavicular group behind and above the upper margin of the pectoralis minor The thoracodorsal nerve, which supplies the latissimus dorsi and which follows the course of the subscapular artery along the posterior margin of the axilla, and the long

thoracic nerve, which supplies the serratus anterior, should be avoided. The latter nerve passes behind the brachial plexus and great vessels, and hugs the chest wall as it passes downward to the serratus. The dissection having reached the chest wall, the mass of tissue obtained from

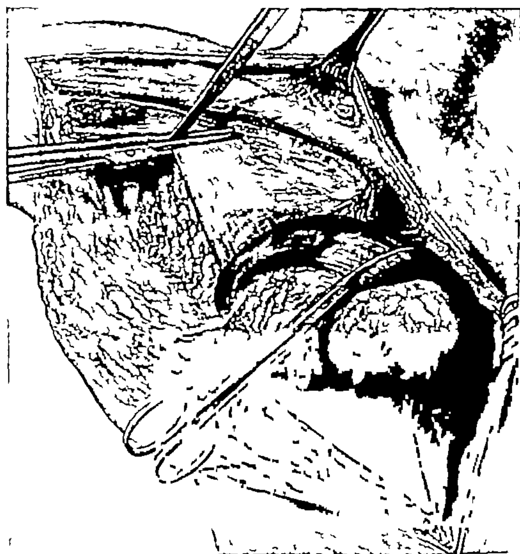


FIG. 40. *Radical Amputation of the Breast* The pectoralis minor exposed preparatory to division

the axilla, the muscles and the mammary gland are dissected medially the assistant covering the freed gland with a moist pack as the operation progresses and pulling it medialward. Perforating vessels are watched for and clamped as they are encountered, and when the dissection reaches the region of the rectus muscle the upper part of the anterior rectus sheath is removed *pari passu* The attachments of the pectoral muscles to the chest wall are severed (Figure 42) until on reaching the sternum the breast and muscles have been removed *en masse* All



FIG. 41. *Radical Amputation of the Breast* Axillary structures being cleared by gauze stripping. Thoracodorsal nerve to latissimus dorsi and long thoracic nerve to serratus are seen

FIG. 42. *Radical Amputation of the Breast.* Breast and muscles being separated from chest wall.

hemostats that remain on the chest wall are tied off and remove hot moist packs are applied to the entire surface of the wound. As are lifted up, any remaining bleeding vessels are clamped and tied

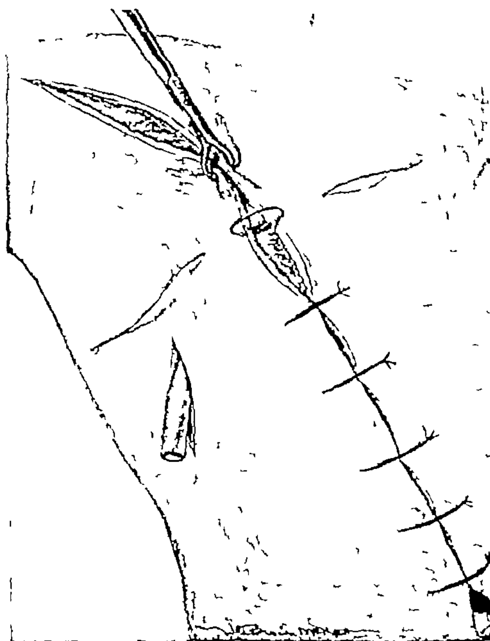


FIG. 43 *Radical Amputation of the Breast* Closure of incision.

no oozing is seen. A stab wound is made through the skin just belo axilla, and through this a rubber tube is introduced and sutured in p The skin is temporarily brought together by towel clamps while a of interrupted sutures of silkworm gut are put in Each suture is i duced about 2 cm from the skin margin of one side and passes thr and out near the edge of the skin of the opposite side Thence it re

to the first side and pierces the skin near its edge and then returns to the opposite side where it comes out about 2 cm from the edge (Figure 43) A hemostat is applied to each end of the suture and after all are introduced a continuous dermal suture is put in Two long Penrose drains are arranged throughout the length of the wound with their ends emerging from the lower margin. The silkworm sutures are now tied. If the skin edges can be approximated only under considerable tension some relaxation may be obtained by making multiple incisions about 2 cm long parallel to the length of the incision throughout the skin flap on both the medial and lateral sides If it is obviously impossible to bring the skin together as much of it is closed as possible and the remainder is left open and skin grafts applied A firm dressing is applied and held in place by adhesive and a binder The drains are removed in twenty four to forty-eight hours. The patients do better if they are kept in Fowler's position after they have recovered from the anesthetic. They are allowed out of bed on the fourth or fifth day postoperatively

POSTOPERATIVE TREATMENT

Dermal sutures are removed on the eighth day but if the wound is under tension the silkworm sutures are left in a few days longer After a radical mastectomy the patient should be encouraged to use the arm starting at the end of a week and gradually increasing the range of motion. When X-ray therapy is indicated, it may be started at the end of ten days.

CHAPTER VIII

The Pleura and Lung

The Pleura and Lung

PREOPERATIVE CARE

The general physical condition of the patient should be improved as much as possible by the use of a high caloric diet, rest, and blood transfusions. When suppurative disease of the lung is present, as in bronchiectasis, penicillin or streptomycin or both are given intramuscularly and by nebulization for several days before the operation. Penicillin is given for a longer period of time to a patient with a patent ductus arteriosus and bacterial endarteritis in the hope of controlling the infection and making the ductus less friable. Postural drainage is used for about a week in bronchiectasis if the patient is able to empty the cavities by this method.

LESIONS OF THE PLEURA AND LUNG

Injury

Compression of the thorax or a blow on the chest wall may cause, besides contusion of the skin and subcutaneous tissues traumatic pleurisy with effusion, and contusion, laceration, or rupture of the lung The effusion may be serous or hemorrhagic in character and may be associated with pneumothorax. A laceration of the lung in closed injuries of the chest is usually due to the penetration of the lung tissue by the broken end of a rib and fracture of the ribs or sternum is a common accompaniment of injuries of the chest. In severe crushing injuries, there may be rupture of the diaphragm and injury to the abdominal viscera, particularly the liver

When the injury to the chest is a penetrating wound and the opening in the chest wall is large enough to allow air to enter the pleural cavity the complication of open pneumothorax is added to the injury to the lung and pleura. Perforation of the pleura permits the escape of air into the tissues of the thoracic wall, and emphysema thus produced may extend over the trunk and up into the neck and face A penetrating

wound of the chest may cause hemorrhage from the lung or from a torn intercostal internal mammary or azygos vessel or the great vessels or heart may be involved the latter injuries usually resulting in death within a short time. In other cases the hemothorax compresses the lung and causes respiratory embarrassment plus the usual symptoms of hemorrhage

Empyema

Acute Empyema Acute suppurative pleuritis is usually a complication of pulmonary disease and shortly after its onset there is a profuse serous exudation into the pleural cavity The exudate changes in the course of a few days to a cloudy fluid that contains fibrin and leukocytes, and the pleura becomes edematous and thickened due to inflammatory infiltration and fibrinous deposits. Again after a few days the effusion becomes purulent in character and fibrinous adhesions may be formed between the parietal and visceral pleurae. In some cases the pus becomes walled off between lobes of the lung, between the lung and mediastinum, or between the lower lobe of the lung and the diaphragm, but as a rule in the early stages the exudate lies free in the dependent portion of the chest.

Chronic Empyema When an acute suppurative pleuritis has not been satisfactorily drained it reaches a stage when improvement no longer takes place and it is said to be chronic. In some of these cases a foreign body such as a drainage tube is present in the pleural cavity· in others, reinfection of the pleural cavity is taking place from osteomyelitis of a rib or from a bronchial fistula and in many of them there is a walled-off collection of pus that does not connect with the drainage tube. As time goes on the pleura becomes thicker and the abscess more firmly walled off, so that even after the pus has been drained the lung is no longer able to expand and collapse the cavity

Tuberculous Empyema Tuberculous empyema may be secondary to tuberculosis of the mediastinal glands but is more commonly a complication of tuberculosis of the lung Serous pleural effusion in pulmonary tuberculosis is very common and empyema is not rare and in any empyema the absence of organisms demonstrable by ordinary smear or culture should make one suspect a tuberculous origin. It should be remembered, however that an empyema that is primarily tuberculous may become secondarily infected by other organisms that reach the pleural cavity through a bronchial fistula or by contamination during aspiration of the chest.

Actinomycosis

Actinomycosis of the lungs or pleura may be primary in the chest or may be the result of extension of the process from an infection in the

jaw or abdominal cavity Multiple abscesses are formed, with numerous dense adhesions and there may be erosion of the ribs or vertebrae, and sinuses that may penetrate the chest wall Sulphur granules are usually easily identifiable in the pus.

Tumors of the Pleura

Metastatic carcinoma of the pleura is very common, particularly following carcinoma of the breast. The pleura is studded with nodules and there is usually a pleural effusion, which may be serous or bloody Sarcoma may similarly involve the pleura, usually as a secondary manifestation. Tumors sometimes classified as endothelioma or mesothelioma are occasionally encountered. In some cases these are believed to be tumors primary in the lung which have extended to and involved the visceral pleura, in others papillomatous masses or pleural infiltration make them appear to be primary in the pleura but the exact nature of the tumors has not been fully determined They are often associated with pleural effusion, either bloody or serous Lymphosarcoma and Hodgkin s disease not infrequently cause diffuse thickening of the pleura or multiple discreet nodules on the pleural surface, associated often with clear or cloudy effusion.

Abscess of the Lung

Localized suppurative necrosis of the lung may take place in any lobe but is most commonly seen in the lower lobe. The abscess is surrounded by a more or less extensive area of inflammatory consolidation inside this is a capsule composed of fibrin or even, in those cases of long duration, fibrous tissue Besides the pus in the abscess cavity there is often a certain amount of air which causes a fluid level to be evident in X-ray pictures taken with the patient in an upright position. Abscess of the lung may be single or multiple but if multiple the lesions tend to be located in close proximity to each other or even intercommunicating Bilateral single abscesses are sometimes seen

Cystic Disease of the Lung

Cyst like cavities in the lung may be seen in bronchiectasis and an air containing sac, a pneumatocele may appear and subside spontaneously in a lung that is otherwise normal. Cystic Disease refers to a developmental anomaly in which cysts are formed single or multiple and varying in size from 2 cm to half the size of the pleural cavity The disease may be met with in children or adults and may involve any part of the lung The wall of a cyst is largely connective tissue, but smooth muscle and cartilage may be seen, and the lining resembles the epithelium of a bronchus A cyst may communicate with a bronchus and infection or hemorrhage may cause the cavity to fill with pus or blood

TUMORS OF THE LUNG AND BRONCHUS

Benign Tumors

Adenoma of the Bronchus This is the most common primary tumor of the lung with the exception of carcinoma Although it is usually classified with the benign tumors it has malignant potentialities The tumor occurs nearly always in a large bronchus where it forms a rounded pinkish mass attached to the lining of the bronchus by a wide base By obstructing the bronchus it may cause atelectasis of the portion of lung distal to it, and by damming up secretions it may predispose to infection

Cylindroma This is a type of bronchial adenoma not distinctive in gross appearance but which has microscopic structure somewhat like that of cylindroma a type of adenocarcinoma of the salivary gland. This particular variety of adenoma appears to be more malignant, metastasis not being rare and invasive characteristics being pronounced.

Fibroma A tumor primarily of fibrous tissue but often containing other structures occasionally occurs in the bronchus. Malignant change may take place in such a tumor but this is very unusual

Lipoma of the Bronchus Developing usually from fat in the bronchial wall, this neoplasm may form a pedunculated tumor that fills or partly fills a bronchus with the usual results of obstruction in the peripheral lung.

Chondroma and Osteoma These rare tumors have been reported developing in a bronchus and resemble similar tumors elsewhere.

Hamartoma This is a neoplasm that contains abnormally distributed and differentiated, the normal component of the organ in which it grows. It has been described in the bronchus and in this location it usually contains smooth muscle cartilage mucosa, and connective tissue

Malignant Tumors

Bronchiogenic Carcinoma Carcinoma of the lung nearly always originates from a bronchus but there is some evidence that it may begin in the alveoli. Any lobe of the lung may be involved but most of the tumors are located in the hilar region, where they arise in the larger bronchi or at the beginning of the secondary bronchi. Obstruction of the bronchus produces atelectasis of the corresponding portion of the lung Metastasis takes place to the bronchial and mediastinal lymph nodes and later to bone kidney liver brain, and elsewhere. The pleura may be involved by direct extension and the growth may extend to the mediastinum, heart, or esophagus Involvement of the periphery of the lung is usually associated with pleural effusion. The presence of an effusion, however does not mean that the condition is inoperable although when a bloody

effusion is observed it is likely to be due to actual involvement of the pleura by the growth. Adhesions between the parietal and visceral pleura may take place with extension of the tumor to the periphery but adhesions of this type should not be confused with adhesions resulting from previous inflammatory disease. When the lung has been exposed, the firm mass of carcinoma can be palpated without difficulty in the soft lung tissue

Metastatic Tumors The lung is the site of secondary tumors in many cases of carcinoma and sarcoma. These secondary nodules in the lung are usually multiple and sharply demarcated.

Bronchiectasis

Dilatation and infection of the bronchi may be congenital or acquired and may involve any lobe of the lung on one or both sides Usually the right lower and middle lobes and the left lower and the lower portion of the left upper lobes are involved With a long-standing process, areas of fibroid pneumonitis localized abscesses, and adherent pleuritis may be present. Empyema may result from rupture of a parenchymal abscess into the pleural cavity and may be associated with a bronchial fistula.

Pulmonary Tuberculosis

Invasion of the lung by the tubercle bacillus may be divided into the stages of infiltration, destruction and cavitation. In the first stage the lung, usually in its upper lobe, becomes firmer than normal, due to the formation of tubercles with cellular and fibrous proliferation. The process goes on to coalescence of the tubercles and destruction of the lung, but concurrently the effort of the body to control the process is shown by fibrosis With loss of the necrotic tissue, cavities are left, and these may develop progressively thicker walls and become secondarily infected by other organisms. The progress of the disease may be arrested at any stage, and cure takes place by resolution of the parenchymatous infiltration, but the thick walled cavities may persist indefinitely Pleural adhesions are very often present and may also persist and interfere with the collapse of a cavity

Tuberculous pneumonia and miliary tuberculosis are two forms of the disease that may occur as a complication of surgery or as a result of spontaneous spread of a previously existing focus of disease.

When the lung is exposed and palpated, the involved portion is less compressible than normal, and the calcified lesions feel hard. With this exception the induration is much less pronounced than that found in carcinoma. The predilection of the disease for the upper portion of the upper lobe and the relative freedom of the hilar structures also differentiate it from carcinoma and most cases of abscess and bronchiectasis.

TREATMENT AND TECHNIQUE

Any operation on the chest that entails wide opening of the pleural cavity should be performed under positive pressure intratracheal anesthesia.

Injury

Injuries of the chest produced by blow or compression should nearly always be treated conservatively If broken ribs are present, the corresponding side of the chest should be strapped with adhesive. Serous fluid or blood that collects in the pleural cavity should not be aspirated for the first three days unless it causes a dangerous degree of respiratory difficulty At the end of that time an attempt should be made to remove blood from the pleural cavity using a large caliber needle If the blood has partly clotted as it may particularly when associated with a thoracic wound one should attempt by repeated aspirations to get it out, since it tends to form in a thick coating over the surface of the lung and parietal pleura and, becoming organized interferes with pulmonary expansion If a large amount of blood is known to be present in the pleural cavity and after a month s observation there appears to be no expansion of the lung decortication of the lung to remove the clot should be performed. Simple incision to remove semiliquid blood occupying the central portion of a clot is not sufficient. A rib is resected subperiosteally—usually the fifth or sixth rib gives the best exposure for the purpose—and the thorax is entered through the rib bed. A rib spreader is inserted and the loose blood in the pleural cavity is removed by scooping and suction, and then the lung is exposed for decortication. Starting at any convenient point, the clot is cut through down to the lung, and, after a cleavage plane has been established, the blood and fibrous tissue are peeled off by blunt dissection. The thorax is closed by the usual method and a drainage tube is left in.

Immediate operation is indicated if there is X ray evidence of laceration of the diaphragm with diaphragmatic hernia, or if there is reason to believe that gross bleeding is taking place and will probably lead to a fatal outcome If the injury is due to a penetrating wound and a large open pneumothorax is present, the opening in the chest wall should be immediately closed by a gauze packing or dressing such an opening is so much larger than the glottis that the patient is unable to aerate the lungs If blood is to be seen coming from the chest cavity preparations are immediately made to find the source of bleeding and stop it. The opening in the chest wall is enlarged if necessary by cutting along an intercostal space and inserting a self retaining retractor Any large foreign bodies, such as pieces of clothing or metal fragments should be removed, but a small object, such as a bullet, should not be sought too extensively The lung is pulled up into the wound and inspected. If it is seen to be torn,

the laceration is closed by interrupted sutures of fine silk or catgut. Lung tissue holds sutures considerably better than the liver does, but if they are tied too tightly they will cut through. Bleeding from the lung during the process of suturing can be controlled by squeezing the proximal portion between the fingers. Large bleeding vessels seen in the depth of a laceration should be caught and ligated individually and in deep lacerations it may be necessary to insert two or three layers of sutures to bring the raw surfaces together After the suturing is completed, the lung should be blown up to be sure that the suture line is reasonably air tight, but no matter how carefully the sutures are inserted if the lung is tightly inflated air can be made to leak out of it. If a portion of lung is macerated or extensively torn, and the hemorrhage cannot be controlled by sutures or packing, it may be necessary to do a lobectomy In other cases, particularly when the condition of the patient is bad, segments of one or two ribs should be resected and the involved portion of the lung pulled through the chest wall and sutured there, so that infective material from macerated lung or a torn bronchus which might otherwise enter the pleural cavity will slough or be discharged to the outside. After such an exteriorization of the lung it may be necessary to do a secondary operation to close the bronchus and return the lung to the pleural cavity

If the blood is not coming from the lung the region of the internal mammary vessels should be inspected, as should the great vessels the hilum of the lung and azygos or hemiazygos vein. The wound of entrance—and of exit, if the latter is present—helps a great deal in determining what regions should be particularly examined. An attempt should be made to suture or tie off any bleeding vessels that are found, the chest wall is closed as well as possible and a drainage tube is inserted and led to a water bottle.

Closed catheter drainage should be used in chest injuries with tension pneumothorax, a variety of open pneumothorax in which the air is able to enter the pleural cavity but cannot escape. In these cases, and in any penetrating wound of the chest, there may be a progressive subcutaneous emphysema, although the condition usually subsides without treatment occasionally it becomes so distressing that measures must be taken to arrest it. If closed catheter drainage of the pleural cavity is not sufficient, it may be necessary to make multiple incisions through the skin to allow the air to escape

Acute Empyema

Penicillin therapy should be instituted When the exudate obtained from the pleural cavity by thoracentesis has become frankly purulent, drainage should be instituted by resecting a segment of rib and inserting a large rubber tube into the pleural cavity through an incision in the rib bed.

A method of drainage that is more satisfactory from the point of view of keeping a closed system but less satisfactory in that it does not permit the use of a large tube is intercostal drainage by means of a catheter In cases of empyema due to the streptococcus the pus is usually thin and there is less tendency for the cavity to become walled off in this particular type of empyema intercostal catheter drainage is to be preferred to rib resection. In children, in the aged or in the extremely sick, intercostal drainage also has its field of usefulness In babies on the other hand the small catheter that can be inserted between the ribs may be less satisfactory than repeated aspiration

Aspiration and injection of penicillin at intervals may be used on any patient, and good results may be obtained without operation.

Technique of Thoracentesis The location of the pus having been determined by physical examination and X ray studies a large-caliber needle is introduced under local anesthesia through an intercostal space that overlies the fluid In most cases the needle is introduced through the eighth intercostal space just below the angle of the scapula. The needle which is attached to a syringe is pushed carefully through the chest wall until it is felt to penetrate the pleura and enter the pleural cavity If it is desired to draw off a large amount of fluid the syringe is removed and the needle is connected to a Potain aspirator

Intercostal Drainage Pus having been located by an aspirating needle a large trochar is introduced under local anesthesia into the pleural cavity the stylet is removed and a catheter that has at least two eyes near its end is introduced through the lumen of the trochar In adults, #20 French at least should be used, but a smaller tube is necessary for children. While the catheter is held in place the trochar is removed. The catheter should enter the pleural cavity not farther than about 5 centimeters and may be held in place by a single suture passed through the skin and tied around it.

Rib Resection Under local anesthesia an incision about 6 cm. long is made parallel to and over the eighth or ninth rib somewhere between the posterior axillary line and the line of the angle of the scapula If the empyema is located elsewhere, the location of the incision is changed accordingly The incision is deepened to the periosteum of the rib which is exposed throughout the extent of the incision While retractors are used to keep the edges of the wound separated the periosteum is scraped off the outer surface of the rib with a sharp rib stripper by means of a costal periosteal elevator the rib is freed from its periosteal bed and 3 or 4 cm. of it are removed with a rib cutter Particular care should be used in this procedure to avoid the intercostal vessels that lie at the lower margin of the rib An aspirating needle is introduced through the posterior periosteum and pleura to confirm the presence and location of the pus, and a small incision is made into the pleural cavity with a knife (Figure 44A)

If it seems advisable a finger is introduced first to determine the lowest level of the cavity and then a large rubber tube with two or three openings cut near its end is inserted (Figure 44B) The tube is held in place by a suture taken in the skin and by a large safety pin in the tube The object should be to place a drainage tube at the lowest possible level in the pleural cavity if pus is not obtained by aspirating at the level where

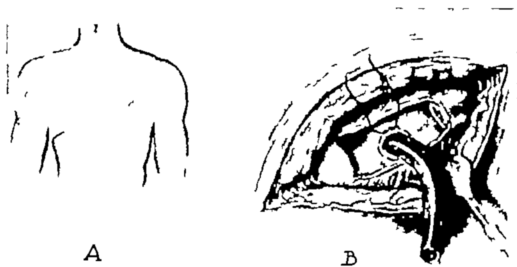


FIG. 44 *Rib Resection and Drainage* A. Incision. B A segment of rib has been resected subperiosteally An incision has been made through the posterior periosteum and parietal pleura and through this a tube has been introduced. It is being held in place by a pursestring suture, one bite of which passes through the wall of the tube

the rib has been resected, or if the cavity extends much lower the incision should be lengthened and a portion of rib above or below removed. After a few days the tube is irrigated with normal saline solution to keep it from becoming plugged, and later the solution is injected to determine the size of the residual cavity If no bronchial fistula is present, Dakin's solution may be used to advantage as an irrigating fluid. The presence of a bronchial fistula is demonstrated if the patient tastes salt when the cavity is being irrigated with saline The tube should not be removed until the cavity has shrunk down to a capacity of from 10 to 20 cc.

Chronic Empyema

The most important principle in the treatment of chronic empyema is the establishment of adequate drainage from the most dependent portion of the cavity and the removal of a foreign body if any is present. The extent and location of the cavity are determined by X ray examination, aided when necessary by Lipiodol injection through the sinus tract. If it is evident that drainage has not been satisfactory a portion of rib is resected at the appropriate location and a large-caliber drainage tube is inserted.

At this time a finger is inserted into the empyema cavity to determine its extent, break down loculations and remove foreign bodies. If this treatment does not suffice more radical measures, such as one of the following operations must be instituted.

Schede Operation Under local anesthesia a U shaped flap of skin and subcutaneous tissue is made over the empyema cavity If the cavity should lie under the scapula the incision should begin between the medial border of the scapula and the vertebral column and continue downward and laterally around the angle of the scapula so that the scapula can be lifted away from the chest wall to expose the ribs All ribs that lie over the abscess cavity are resected subperiosteally over the extent of the cavity and a short distance beyond An incision is made through the periosteal bed of one rib and the parietal pleura and the roof of the abscess cavity which consists of intercostal muscles periosteum, and parietal pleura, is cut off The flap of skin muscle and fascia is then replaced and sutured in position with chromic catgut for the deeper tissues, and dermal or silkworm gut for the skin. Drainage by means of one or two rubber tubes is established in the lowest portion of the cavity and a pressure dressing is applied to push the tissues of the thoracic wall inward against the lung When a large number of ribs must be resected over a great extent, it is best to do the operation in two or more stages

Estlander's Operation This operation is similar to the Schede operation except that the abscess cavity is not unroofed. The ribs are resected over the cavity and then the skin and subcutaneous tissues are replaced. The collapse of the chest wall obtained by this operation is not sufficient in many cases.

Fowler Delorme Operation Removal of the thickened visceral pleura or decortication of the lung may sometimes be combined to advantage with the Schede operation. After the visceral pleura has been thoroughly exposed by unroofing the cavity it is carefully peeled off the lung Bleeding points may be encountered and should be caught and tied. In some cases decortication can be accomplished without much difficulty but in others the peeling off of the pleura may be practically impossible Part of the pleura may be removable, and if the operation must then be abandoned the remainder of the tissue may be treated by Ransohoff's technique. The thickened visceral pleura is crosshatched by incisions that extend through the pleura to the lung and are located about 1 cm. apart.

Bronchial Fistula

Most fistulas close spontaneously but in some cases operation may be necessary The abscess cavity should be exposed by the Schede operation and adequate drainage of the empyema cavity established and the opening of the fistula touched with silver nitrate. If this is not sufficient, the wound may be reopened, the opening of the fistula closed by sutures and

a portion of intercostal muscle that has been left attached at its vertebral end is sutured down over the opening. In some cases lobectomy may be necessary to cure the fistula.

Tuberculous Empyema

Empyema due to the tubercle bacillus should not be treated surgically unless absolutely necessary Occasionally aspiration of the pus may be required, if so the most meticulous care should be used to avoid secondary infection of the pleural cavity A bronchial fistula or mixed infection through a tuberculous sinus may make drainage necessary but in many cases so treated the lung does not expand and a thoracoplasty must be done later

Actinomycosis

The treatment of this disease should be extremely conservative and is confined to draining easily accessible abscesses in the chest wall or in the pleural cavity plus medical measures. Penicillin is often very effective.

Tumors of the Pleura

A primary tumor of the pleura is a rare condition, but if it should be encountered on exploration of the thoracic cavity the involved portion of the pleura should be removed if possible.

Abscess of the Lung

If postural drainage and drainage by means of the bronchoscope, together with penicillin therapy are ineffective and the abscess does not soon show steady progress in healing, it should be drained. The abscess is located by X ray examination and, under local anesthesia, an incision about 7 cm. long is made over a segment of rib that most nearly overlies the cavity About 5 cm. of the rib is resected subperiosteally and the posterior periosteum is carefully stripped up to expose the parietal pleura. If the parietal pleura appears to be thin and not fused to the visceral pleura, it should not be opened. If it seems advisable a rib above or below the one already exposed is resected and the pleura similarly inspected at that point. If the pleural leaves at this point also are seen to move, a gauze pack should be placed against the pleura and the wound closed over it by a few interrupted sutures of silkworm gut. If the pleura should be opened by accident, the pleural cavity may be explored by the finger to determine if there is a point of pleural fusion and where it is located. When this observation has been made the pleura is closed and a portion of rib is resected over the adherent area, the periosteum and parietal pleura incised, and a rubber drain introduced. If the abscess is of fairly good size it is not sufficient to establish drainage by a single tube but the abscess should be unroofed by resecting ribs over the entire cavity as in the Schede operation.

If the pleura was not opened and packing was inserted against it, the second stage of the operation should be done about a week later when adhesions have taken place The wound is reopened and a large-caliber needle is inserted to confirm the presence and location of the abscess,

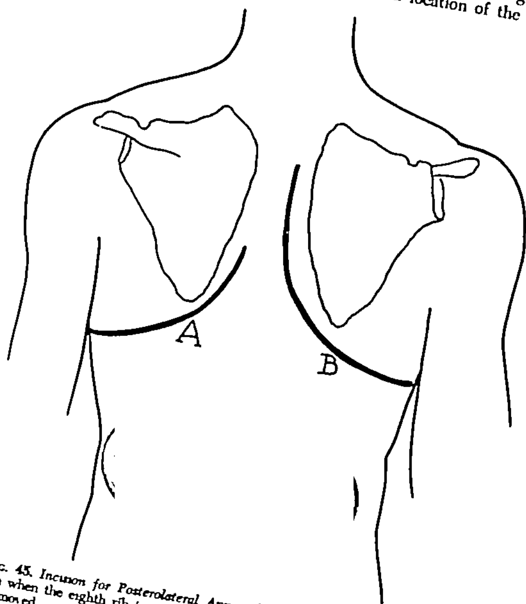


Fig. 45. *Incision for Posterolateral Approach to the Thoracic Cavity* A. Incision when the eighth rib is to be resected. B. Incision when the fifth rib is to be removed

after which the pleura is incised, the abscess cavity explored with the finger and a drainage tube inserted. The wound is closed very loosely or not at all, but the tube is held in place by a pursestring suture in the pleura and a silkworm suture in the skin, the ends of the latter being tied around the tube.

In some cases when the abscess is very thick walled, adequate drainage may not cause it to close, and lobectomy may be required.

Cystic Disease of the Lung

The cyst or cysts should be removed if symptoms are present. This nearly always entails removal of the involved portion of the lung by lobectomy or pneumonectomy

Carcinoma of the Lung

If there is no definite evidence of distant metastasis or involvement of the pleura, and after treatment of any acute inflammatory disease of the lung due to bronchial obstruction, the lung should be explored with the object of doing a pneumonectomy. The operation may be performed through an anterior approach with resection of the third rib but the posterolateral approach has certain advantages and it will be described.

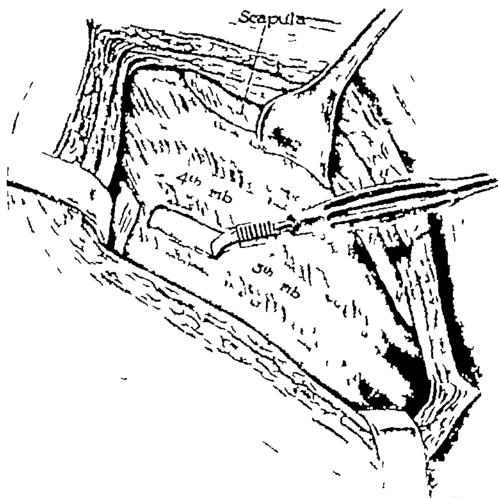


Fig 48 Posterolateral Approach with Resection of the Fifth Rib The incision has been deepened down to the ribs, the scapula has been drawn upward and outward and the periosteum is being scrapped off the fifth rib.

Technique of Opening and Closing the Thorax (Posterolateral Approach) The patient is placed on his side and held in position by sand bags. An incision is made that begins between the inner border of the

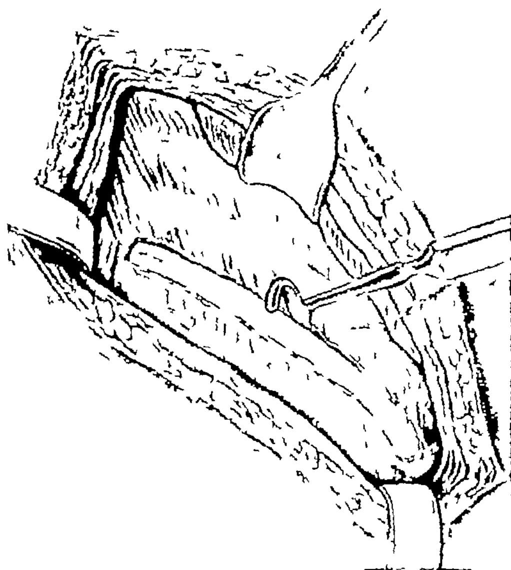


FIG. 47 *Posterolateral Approach with Resection of the Fifth Rib* A periosteal stripper is being used to separate the rib from the underlying periosteum When the upper border has been freed, the lower border will be similarly stripped, particular care being used to avoid the intercostal vessels under the lower edge of the ribs.

scapula and the vertebral column and curves downward and outward around the angle of the scapula to the midaxillary line (Figure 45A) The chest is usually entered through the bed of the fifth or the eighth rib depending on the nature of the operation to be performed. For pneumon

ectomy the higher approach is used, but to remove the lower lobe of the lung the bed of the eighth rib is chosen In cases where no great exposure of the thoracic cavity is necessary an intercostal incision may be

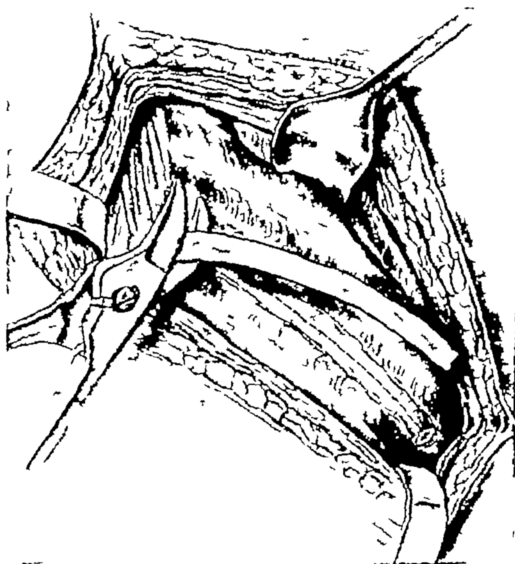


FIG. 48 *Posterolateral Approach with Resection of the Fifth Rib* The rib is being removed The dotted line shows the line of incision in the periosteal bed and through the pleura.

used instead of the rib resection. The principle of this is the same as the rib-resection method about to be described.

If the fifth rib is to be resected the incision is begun at the level of the second thoracic spine, and, after passing around the scapula, may be terminated at the midaxillary line or continued forward to the fifth rib in the anterior axillary line (Figure 45B) The incision is deepened down to the ribs, the cut muscles are retracted, and the scapula is pulled outward to give access to the fifth rib In case the eighth rib is to be re-

moved, the incision is made lower down and little retraction of the scapula is necessary The fifth rib is identified by passing the hand up under the scapula and counting the ribs from above. The periosteum is scraped off

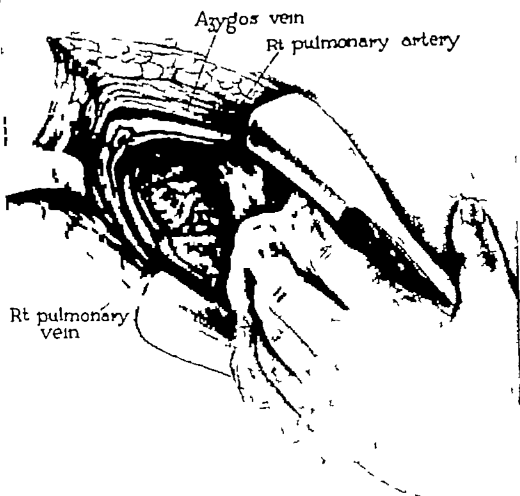


FIG. 49 *Posterolateral Approach with Resection of the Fifth Rib* The pleura has been opened, a self-retaining retractor has been inserted, and an incision has been made through the mediastinal pleura at the root of the lung, exposing the hilar structures

the outer surface of the rib (Figure 46) and a costal periostome is passed around the rib to separate it from the posterior periosteum and inter costal vessels, the latter lying underneath the lower edge of the rib (Figure 47) Care should be used in this procedure to avoid puncturing the posterior periosteum and parietal pleura. The rib having been freed throughout the length of the incision, it is cut off with rib shears and removed (Figure 48) The periosteum and parietal pleura are incised in the rib bed, particular care being taken in making the first opening, be-

the sutures are tightened the ribs are pulled together (Figure 50) The pleura, periosteum and intercostal muscles are closed by two layers of continuous catgut sutures or interrupted sutures of silk. Before the last suture of the pleura is put in, a hemostat is inserted into the pleural cavity and held open while the anesthetist expands the lung if it has not been removed. When the suture lines have been completed, the tension sutures are removed, but if an intercostal thoracotomy has been performed it is advisable to leave them in, since it is difficult to get as satisfactory a closure The scapula is allowed to drop back in place and the muscles are closed by two layers of continuous catgut sutures after which interrupted sutures of silkworm gut and dermal are used for the skin.

Pneumonectomy The thoracic cavity having been exposed by an incision through the bed of the fifth rib any pleural adhesions found are separated if possible and the lung is mobilized so that the region of the hilum can be explored Dense fixation of the lung or the hilar structures means that the case is inoperable. Extension of the tumor to the pericardium calls for removal of that portion of the pericardium to remove the growth this can be done if the involvement is limited. If it is decided to do a pneumonectomy the hilum of the lung is exposed by cutting the mediastinal pleura on the posterior surface of the hilum and reflecting the membrane away from the bronchus and vessels The phrenic nerve, which is seen coursing along the pericardium, is crushed to produce a temporary paralysis of the corresponding half of the diaphragm. The pulmonary ligament attached to the pericardium and upper part of the diaphragm is isolated and cut between clamps to mobilize the lower lobe of the lung. Preparations are now made to ligate individually the hilar structures, but on the right side this is preceded by ligation and section of the azygos vein where it extends over the main stem bronchus. In the posterolateral approach on the right, the first hilar structure to be dealt with is the bronchus, since the pulmonary artery lies in front of it (Figure 51B) On the left side, the pulmonary artery lies behind the bronchus and is dealt with first (Figure 51A) Isolation of bronchus and vessels is accomplished by blunt dissection, using cotton pledgets held in long thumb forceps, and by judicious use of a curved hemostat. The bronchus is exposed almost up to the carina and care is used not to tear the bronchial vessels. The bronchus is cut off between two heavy hemostats, 1 to 1.5 cm. distal to the carina, but if there is a question about the extent of the tumor the bronchus should be opened so that the tumor can be seen and section made above it. Any contamination of the pleural cavity should be prevented during this procedure by continuous aspiration of the exuding secretions. The proximal stump is closed by two layers of interrupted silk sutures, the first consisting of mattress sutures, which are applied proximal to the hemostat, after these are tied the hemostat is removed. Another series of interrupted silk sutures is then applied distal to

the first row these being simple through-and through sutures which are tied over the crushed end of the bronchus The hemostat applied to the distal bronchial stump is used to retract the bronchus, and aids in exposing the right pulmonary artery The pulmonary artery is separated from the aorta, bronchus, superior pulmonary vein, and the pericardial sac. The pulmonary artery and the pulmonary veins are large in diameter in fact the diameter may be greater than the length of vessel that can be

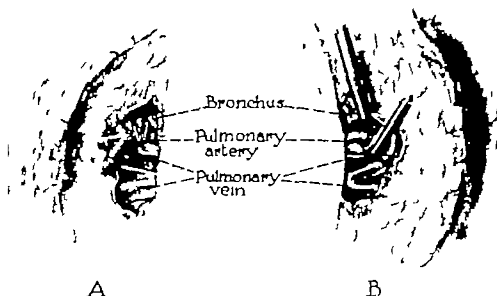


FIG. 51 *The Hilar Structures As Seen in the Posterolateral Approach.* A. Posterior aspect of the hilum of the left lung The pulmonary artery has been ligated and cut to expose the underlying bronchus B Posterior aspect of the hilum of the right lung The bronchus has been cut and pulled aside to expose the underlying pulmonary artery

exposed for ligation, and in some cases it is necessary to ligate them within the pericardial sac. Two ligatures of silk or catgut are applied to the artery as far apart as possible and a short distance distal to the upper one a transfixion ligature of the same material is applied. The artery is cut between the transfixion ligature and the distal ligature. The pulmonary veins are next dissected out and ligated in the same manner as the artery but if they are too short a clamp may be applied to the lung just beyond the transfixion ligature and the distal ligature dispensed with. On the left side after the artery has been cut, the bronchus and finally the pulmonary veins are dealt with. The recurrent laryngeal nerve should be guarded during the isolation of the bronchus on this side. The regional mediastinal lymph glands are dissected out, and small vessels torn in the process are caught and ligated. The lymph glands can be easily recognized by their pigmentation. If the growth has extended to the pericardium a section of the membrane may be removed at this time. The

mediastinal pleura is now brought together over the stump of the vessels and bronchus, and sutured in place with interrupted sutures of catgut. This procedure is very important, and if necessary the mediastinal pleura may be mobilized still more or a flap turned down from the pericardium to use as a pedunculated patch.

At the conclusion of the operation it is wise to elevate the foot of the bed during the early postoperative period. Oxygen intravenous fluid, and blood should be given as indicated. Unless there has been infection the pleural cavity is closed without drainage otherwise an intercostal tube is inserted through a stab wound in the ninth intercostal space in the posterior axillary line and connected to an apparatus to provide continuous suction drainage.

Benign Tumors of the Bronchus

Fibroma, chondroma, osteoma hamartoma, lipoma, and any of the rare benign tumors of the bronchus should be removed whenever possible by bronchoscopic means. Radon seeds may be implanted and surgical diathermy may be used if necessary If the tumor cannot be removed in this way and obstruction of the bronchus with inflammatory symptoms is present, lobectomy is necessary Adenoma of the bronchus may be removed in many cases by bronchoscopic methods but it usually recurs. Lobectomy is the treatment of choice in the good risk patient, particularly when the tumor has a broad attachment. It should be kept in mind also that biopsy by means of the bronchoscope is not infallible and in some instances what is thought to be a benign tumor may actually be carcinoma. Pneumonectomy may be necessary in some cases because of the size or location of the growth. The tumor may or may not be palpable in the lung on exploration and accurate localization preoperatively by means of the bronchoscope and lipiodol studies is essential.

Lobectomy For removal of the lower lobe the posterolateral approach with resection of the eighth rib is satisfactory but the seventh rib may be removed instead if desired. In order to do the higher dissection of the hilum necessary to remove an upper lobe, the fifth rib should be removed. The usual and preferred method of performing lobectomy is by individual ligation of the hilar structures This procedure should be followed unless inflammatory changes in the region make it impossible, but this complication is more apt to be encountered in bronchiectasis than in adenoma of the bronchus

If a lower lobe lobectomy is to be performed, the pulmonary ligament is doubly clamped, cut, and ligated (Figure 52) and the lung is inspected to determine the location and depth of the interlobar fissures The proper fissure is selected and carefully developed toward the hilum. Since the right middle lobe is often incompletely separated from the rest of the lung, it may be easier in some of these cases to remove both middle and

lower lobes if the fissure between the upper and middle lobes is be developed. The mediastinal pleura is incised over the root of the lung the branch of the pulmonary artery to the lower lobe is identified by

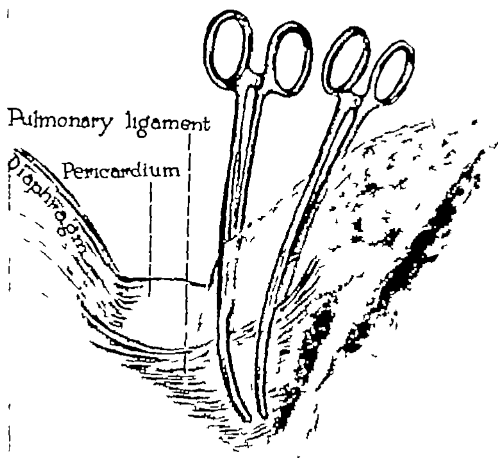


Fig. 52 *Clamping the Pulmonary Ligament Preparatory to Dividing It.*

spection and palpation. A curved hemostat and cotton pledgets are u to free the vessel from the surrounding lung tissue and often suffici length can be obtained to permit ligation by an encircling and a tra fixion ligature above and an encircling ligature below The artery is between the lower ligatures If the artery is too short, it is cut betwe heavy clamps and the ligatures are then applied. Lymph nodes should removed as they are encountered, and any small bleeding vessels caught and tied. The veins, which are next to be isolated, may be clos adherent to the bronchus and careful blunt dissection may be necess to free them If the vein has divided into several tributaries at the po where it is most accessible it may be safer to ligate all these *en ma* rather than attempt to ligate the small vessels individually On the l side the vein that supplies the lower lobe is usually longer than on t

right and the main trunk can be ligated in most cases A constant branch of the pulmonary vein lies at the point of attachment of the pulmonary ligament to the lower lobe, and this should be dissected out and tied near the hilum. The lower lobe bronchus should next be identified It can easily be felt through the lung tissue and should be exposed as high up as possible On the right side the branch that goes to the dorsal segment of the lower lobe may require separate ligation, but on the left the main lower lobe bronchus can usually be isolated high enough up so that this is not necessary The bronchus is cut between clamps and the proximal end is closed as described under pneumonectomy Lung tissue between the lobes is separated by blunt dissection After the lower lobe has been completely freed, a few interrupted sutures of catgut may be inserted to cover the raw surface. By bringing together the mobilized mediastinal pleura, the raw surface is covered

Lobectomy by the Mass Ligation Technique This is an undesirable method and should be avoided if possible After the pulmonary ligament has been cut the fissure is developed between the lower lobe and the adjacent lung, the dissection toward the hilum being closely followed by

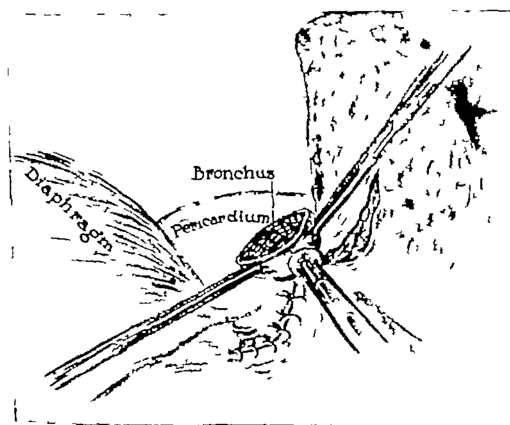


Fig. 53 *Lobectomy by Tourniquet Technique* The pulmonary ligament has been cut and the lower lobe freed from the lobe above it. Bronchus and vessels have been sutured in the stump, and after removal of the tourniquet the lung tissue of the stump will be sutured over them

lock stitches to control hemorrhage At the point of attachment of the pulmonary ligament to the lower lobe, a large vein will be disclosed by careful dissection. After this has been ligated it will materially decrease the size of the hilar mass. The lobe having been freed as much as possible, two tourniquets are applied around its root and two hemostats are placed just distal to the proximal tourniquet to keep the stump from slipping out of its grip The pedicle is divided far enough from the proximal tourniquet to make it possible to close the vessels and bronchus individually After this has been done by suture ligatures (Figure 53) the stump is held by hemostats while the tourniquet is loosened, if more bleeding vessels are seen they are caught and tied. The tourniquet is then removed and the stump of lung tissue with its pleura is sutured together over the closed vessels and bronchus Continuous suction drainage by means of an inter costal tube is advisable the tube being passed through a stab wound in the ninth intercostal space in the posterior axillary line.

Metastatic Tumors of the Lung

These are inoperable with the exception that when a solitary metastatic hypernephroma is present in the lung and the primary tumor has apparently been completely removed, it may be justifiable to remove the secondary pulmonary lesion by lobectomy or pneumonectomy

Bronchiectasis

In certain cases of bronchiectasis, lobectomy is indicated When the left side is involved, the left lower lobe and often the lingula, which is a lower portion of the left upper lobe that extends forward, are removed (Figure 54) In involvement of the right side, removal of the lower and middle lobes is usually indicated. Lobectomy is done in nearly all cases by the individual ligation technique described under Adenoma of the Bronchus (page 153) On the left side, the lower lobe is removed first and then the lingula, and on the right the lower and middle lobes are removed at the same time.

Lingulectomy and Segmental Resection

Lobectomy of the lower lobe is usually performed through an incision in the bed of the eighth rib but to obtain satisfactory exposure to remove the lingula, short posterior segments of the seventh and sixth ribs should also be removed. The left lower lobectomy having been completed and the hilar stump sutured over with mediastinal pleura, the pleura is incised upward and dissected back to expose the root of the upper lobe. With the use of cotton pledgets on forceps, the parenchyma of the lung is dissected distally to expose the upper lobe bronchus and the vessels that accompany it. The bronchus to the lingula, which may be independent or may arise from the upper lobe bronchus is mobilized and clamped gently When the

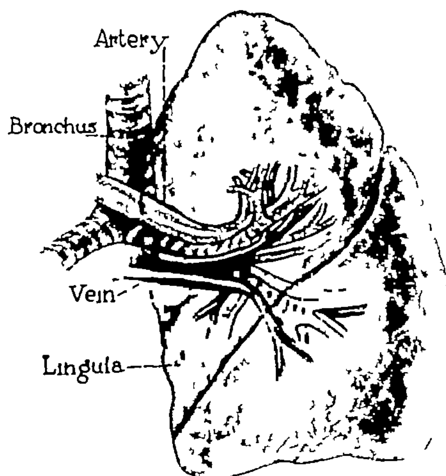


FIG. 54. *Diagram of the Arrangement of Blood Vessels and Bronchi, Anterior Aspect of Left Lung* The lingula with its blood supply and bronchus is shown.

lung is then inflated by the anesthetist, the lingula should remain atelectatic. The bronchus is divided between clamps, and the clamp on the distal stump is used for traction during the subsequent dissection. The artery supplying the lingula is identified by dissection and palpation, and it and the vein are doubly clamped and ligated. A ligature is applied proximal to both clamps and a transfixion ligature is applied distal to this before a vessel is divided. With control of the blood supply the lingula can be separated from the rest of the pulmonary parenchyma by blunt dissection, and there will be very little bleeding Occasionally it will be necessary to clamp and tie a small intersegmental vessel if necessary a few interrupted

sutures of catgut can be inserted to bring the raw surfaces of the lung together but usually this is not necessary The dissection is continued peripherally until the lingula has been removed. The stump of the bronchus is dealt with as described under Pneumonectomy (page 151) The pleural cavity should be drained by an intercostal tube and continuous suction.

For purposes of resection it has become recognized that each portion of lung supplied by a larger artery and bronchus may be recognized as a bronchopulmonary unit and as such may be removed independently of the rest of the lung In some cases rudimentary fissures or notches will suggest a pulmonary segment, and in other cases there may be a difference in the amount of pigment, but such recognizable boundaries are not essential to the procedure. The bronchus supplying the segment in question can be identified by palpation and dissection. When it is lightly clamped and the rest of the lung inflated, the atelectatic segment will be plainly evident and a dissection can be conducted between the atelectatic portion and the expanded portion, with comparatively little bleeding The importance of this is that occasionally particularly in bilateral bronchiectasis, it is necessary to conserve as much normal lung tissue as possible, and the resection may be confined to diseased segments only The technique of a segmental resection is the same as that described in resection of the lingula. Dissection at the hilum to isolate the bronchus and artery supplying the diseased segment is the first step When this has been accomplished, blunt dissection along the line between atelectatic and normal lung tissue can be accomplished with minimal bleeding Occasionally a small bronchiole will be cut and will require ligation, and a few intercommunicating arteries and veins must also be tied.

Pulmonary Tuberculosis

Two surgical procedures, phrenicectomy and thoracoplasty have been of incalculable value in the treatment of certain types of tuberculosis. Pneumonectomy lobectomy and segmental resection also are being used in certain carefully selected cases in which bed rest and collapse therapy have failed. In tuberculosis, separation of the lung from the chest wall must be carefully done by sharp dissection, and occasionally it is necessary to remove the parietal pleura, particularly where it is adherent over a thin walled cavity The bronchus should be temporarily ligated as early in the dissection as possible, to prevent the spread of the disease by this route After ligation and division of the artery the bronchus can be dealt with as usual.

Phrenicectomy Interruption of the phrenic nerve is described in the chapter on The Neck. Temporary paralysis produced by cutting the nerve and its tributaries or simply crushing it, is largely supplanting the permanent paralysis induced by avulsion.

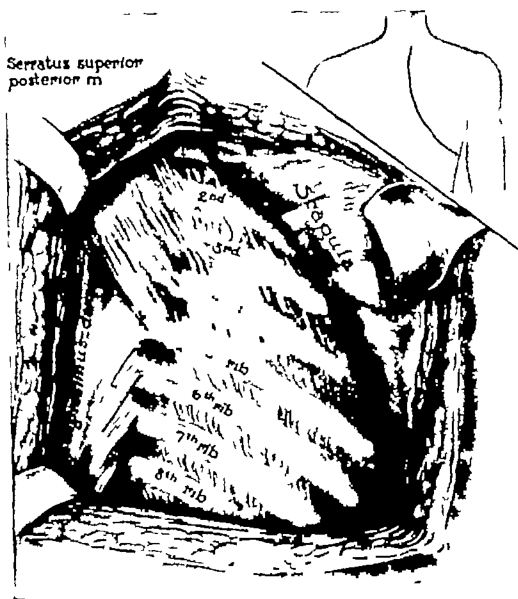


FIG. 55 *Thoracoplasty* Insert shows incision. Incision has been made down to the ribs and the scapula has been pulled upward and outward. The serratus superior and longissimus dorsi muscles will be separated from the ribs. The second and third ribs will be removed from the transverse process to the cartilage and the first rib will be entirely removed along with the cartilage. The transverse process and underlying stumps of ribs may also be removed.

Thoracoplasty The patient is placed on his side on the table with the diseased lung upward and is held in place by sandbags The operation should be done under local anesthesia. An incision similar to that used in pneumonectomy is made. It starts halfway between the scapula and the vertebral column and extends from above the spine of the scapula down and around the angle of the scapula to the midaxillary line. The incision is deepened down to the ribs and the scapula is pulled upward and outward (Figure 55) Bleeding vessels encountered are clamped and li

gated. The rhomboid muscles and all except the upper 2 or 3 cm. (trapezius are cut, and the latissimus dorsi is divided forward th the length of the incision. The hand is inserted up under the sc and the first rib is identified by palpation. The serratus posterior su is cut at its attachment to the upper ribs, and the attachments c serratus anterior to the ribs are divided around to the axilla. Th lenus posterior is separated from the second rib The periosteum (third rib is stripped off as described under the technique of openin closing the thorax (page 147) and the rib is removed subperios from the transverse process to the cartilage For convenience the j rior segment may be freed and removed separately and if the tran process and underlying rib segment are removed, as advocated by more complete collapse is obtained. The second rib is removed i same way and attention is directed to the first rib The rib is freed the scalenus medius and scalenus anterior and removed with most cartilage back to the transverse process The wound is closed usin gut for the muscles and dermal and silkworm for the skin.

Second Stage Three or four weeks later depending on the con of the patient, the lower portion of the wound is reopened and the fo fifth, sixth, and sometimes a short portion of the seventh ribs ar moved. To expose the posterior segments of the ribs the back mu the longissimus, iliocostalis dorsi and spinalis should be severed their attachments to the ribs and pulled backward. The operation also be divided into three stages, removing two and a half ribs at th stage the remaining half of the third rib and the fourth and fifth ri the second stage and the posterior portions of the remaining ribs (to and including the seventh at the third stage At the conclusion c operation a pressure dressing is applied

Complementary Anterior Thoracoplasty In occasional cases it ma advisable to remove the costal cartilages of the second third, and fo ribs and costal stumps through an anterior approach. A curved inc with a dorsal convexity is made in the anterior axillary line, and breast and pectoral muscles are retracted anteriorly the origin of pectoralis minor being separated from the ribs. The cartilages and stumps are removed subperichondrially or subperiosteally as far in as the sternum. A pressure pad is applied to push the chest wall inw the wound is closed by allowing the pectoral muscles to drop back place, and a continuous suture of catgut is inserted in the deeper tis dermal and silkworm being used for the skin.

POSTOPERATIVE CARE

Blood should be given freely by transfusion, and the fluid bal and nutrition should be maintained by the use of adequate amount normal saline, glucose and amino acids. The patient should be pl

in bed with the operated side down but after he has recovered from the anesthetic he should be put in Fowler s position. Oxygen should be given if there is more than a slight degree of cyanosis Bronchial secretion may have to be removed by the bronchoscope if postoperative atelectasis de velops but steam inhalations and an expectorant cough mixture help in loosening the mucus. Penicillin therapy should be continued during the first four or five days after the operation and sulfadiazine in addition to the penicillin helps in preventing empyema. Pleural effusion, which nearly always develops after thoracotomy is drained by closed suction on the indwelling catheter when one is left in otherwise the fluid is aspirated from time to time to reduce the intrapleural pressure to a negative reading The catheter is usually removed in about three days, and subsequent fluid, if excessive in amount, should be removed by aspiration. If empyema should develop it is treated by closed-catheter drainage with penicillin injections.

CHAPTER IX

The Mediastinum and Contents

The Mediastinum and Contents

PREOPERATIVE TREATMENT

For operations on the mediastinal structures, fluid deficiencies should be corrected by intravenous injections, and transfusions should be given in the presence of anemia. Because of the magnitude of most of these operations, a liberal supply of blood should be available for use during and immediately after surgery For operations on the esophagus, nutritional deficiencies should be corrected by parenteral administration of vitamins, amino acids, and glucose in some cases a preliminary jejunostomy may be necessary for feeding purposes If there is a possibility that total gastrectomy may be necessary the jejunostomy should be made far enough down in the jejunum so that it will not interfere with the use of the first segment of jejunum, which is to be anastomosed to the esophagus Oral sepsis should be eliminated by removal of carious teeth and treatment of infected gums When an ulcerating carcinoma of the esophagus is present, daily irrigations of the upper esophageal segment by means of a Levine tube, introduced not quite down to the lesion, is helpful. Sulphasuccidine should be administered daily for five or six days before the operation, as is done before surgery of the colon. If the drug is unable to pass down the esophagus, only very small doses can be used. Before operation a Levine tube should be passed into the stomach and the stomach emptied if this cannot be done the tube should be put in as far as the obstructing tumor and the esophagus emptied The tube is left in place during the operation and for some days thereafter

THE MEDIASTINUM

The mediastinum is divided for descriptive purposes into four parts *The superior mediastinum is located above the level of the pericardium,* and below the superior mediastinum are the anterior middle, and posterior divisions. The anterior mediastinum is located in front of the pericardium largely to the left of the midline. It contains only areolar tissue,

a few lymph glands and lymphatic vessels and small branches of the internal mammary artery The middle mediastinum contains the heart and great vessels the bifurcation of the trachea, some of the bronchial lymph glands, and the phrenic nerves. The posterior mediastinum which is located between the heart and the vertebral column, contains the thoracic portion of the descending aorta, the esophagus the thoracic duct, the azygos and hemiazygos veins and the vagus and splanchnic nerves

Mediastinitis

Mediastinitis is not a common condition, but it may occur as an extension of infection in the neck or may follow a penetrating wound of the chest, rupture of the trachea or esophagus from new growth or instrumentation and occasionally is the result of empyema or osteomyelitis of the ribs, vertebrae, or sternum. The infection may be of the acute fulminating type with an early fatal termination, or there may be suppuration and abscess formation.

Tumors of the Thymus

Enlargement of the thymus gland may occur in Hodgkin s disease, leukemia, exophthalmic goiter and status lymphaticus and benign hyperplasia may take place in infancy Surgical treatment, however, is not indicated in any of these conditions. Hyperplasia of the thymus gland is also found in myasthenia gravis, although in this disease the gland may appear perfectly normal or may be the site of a benign or malignant tumor

There are several types of thymic tumors and their pathologic classification is still incomplete. The entire gland may be converted into neoplastic tissue, or a distinct tumor may be present in what appears to be normal thymus Two types of benign thymic tumor (thymoma) are described. In one of these the neoplasm is composed of cells resembling lymphocytes, but with more cytoplasm and showing a tendency to form Hassall's corpuscles. The other is made up of islands of what appears to be normal thymus growing in a matrix of fat. The malignant tumors are divided by Symmers[1] into seven types lymphocytic, lymphoblastic thymic reticuloid-cell, perithelial, granulomatous, carcinomatous and teratoid. Most of these cannot be differentiated by their gross appearance and it seems unnecessary to go into their microscopic description here

The malignant tumors are usually nodular and hard in consistency but some are soft and vascular They tend to be encapsulated but are locally invasive, involving the lungs and pericardium, surrounding and compressing the great vessels, and sometimes invading the sternum, thyroid,

1 Symmers, D : Malignant Tumors and Tumor-like Growths of the Thymic Region, Ann. Surg 95 544, 1932.

trachea, and even the myocardium Widespread metastasis takes place in about one third of the cases. In late stages, in addition to the usual symptoms of mediastinal tumor (cough dyspnea, pain, swelling of the neck) pericarditis with effusion obstruction of the trachea or esophagus, hydrothorax, and enlargement of the cervical glands may occur Myasthenia gravis is present in some cases, apparently regardless of the type of tumor

Cysts of the thymus gland may be small and multiple and apparently embryonic in origin and similar small cysts are associated with lymphocytic infiltration and dilatation of Hassall s corpuscles Larger cysts may be lymphangiomatous or dermoid, the latter resembling dermoid cysts as found in other locations.

Tumors and cysts of the thymus are located at first in the superior or anterior mediastinum or both, but with growth they may encroach on either pleural cavity

Tumors and Cysts of the Mediastinum

Dermoid Cyst and Teratoma This is one of the most frequently en countered varieties of mediastinal tumor It is found almost always in the anterior mediastinum where it is met with about as often as lymphoma. The *dermoid is a cystic tumor derived from ectoderm*, and the teratoma which may be cystic or solid or both, is derived from more than one germinal layer Others consider dermoid to be derived from ectoderm and mesoderm, and teratoma to contain also entoderm. Both tumors are encapsulated and may be lobulated and uni or multi locular Areas of thickening of the cyst wall and calcification are commonly pres ent Cartilage or muscle may be present and bone, teeth, hair and other recognizable ectodermal structures may be seen. Brownish fluid that contains fat and cholesterin crystals or caseous material may be present in the cyst The tumors may be pedunculated and may attain enormous size, some having been reported that contained 5000 cc. or more of fluid. The teratomas usually contain relatively more solid tissue than the der moids Most of the malignant tumors are found in the solid type but squamous-cell carcinoma may arise in a dermoid. The incidence of ma lignancy in these tumors as a whole is estimated between 15 and 45 per cent. The tumors from their origin behind the sternum in the region of the great vessels and pericardium may present at the suprasternal notch or above the sternoclavicular joint but commonly extend into either thoracic cavity Infection may take place in the cyst and it may rupture into the pleural cavity or into a bronchus and empyema, mediastinal abscess or osteomyelitis of the ribs may result.

Lymphoma Lymphocytoma, Lymphosarcoma Leukosarcoma, and Hodgkin s Disease This group of tumors may arise from the mediastinal lymph glands or in some cases from the thymus, and are encountered in

the anterior mediastinum. With the exception of simple lymphoma, they are malignant tumors and may infiltrate among the mediastinal structures and invade them. Distant metastasis may occur When the tumor arises from the lymph glands the glands may coalesce into a solid mass or may remain discrete and undergo individual enlargement.

Neurogenous Tumors· Occurring nearly always in the posterior mediastinum is a group of tumors that arise from intrathoracic nerve tissue. The tumors are usually single and may reach very large size almost filling one side of the thorax. They may arise from a spinal or a sympathetic nerve, and microscopically can be divided into a large number of different classes, the terminology of which is not yet standardized Some of the tumors about 40 per cent according to some authorities are malignant. Erosion of the ribs may take place, and when the tumor arises from a nerve in a spinal foramen X ray examination may demonstrate erosion of the pedicles or laminae and enlargement of the foramen. In gross appearance the tumors are usually smooth, encapsulated, and grayish in color When lobulation is present it is suggestive of malignancy

Bronchiogenic Cysts Cystic tumors of the mediastinum may arise from bronchial or tracheal anlage and are commonly located in the region of the trachea and bronchi more often on the right. They usually are rounded and thin walled, contain milky or clear fluid, and are sometimes partly filled with air The cysts are usually not large, most of them being less than 5 cm in diameter but they often become infected. Cartilage epithelium, mucous glands fibrous tissues, and smooth muscle are seen in the cyst wall.

Gastro-enterogenous Cysts In the posterior mediastinum particularly and usually on the right side, cysts may be encountered that have their origin in the primitive gastro intestinal tract. The cysts are smooth walled, the wall being composed of connective tissue and frequently smooth muscle, and the cyst may be lined by gastric or intestinal mucosa. These cysts are rare and most of the patients in whom they have been encountered were infants or young children.

Hemangioma and Lymphangioma These are rare tumors that may develop from the blood vessels or lymph vessels respectively and may apparently occur in any part of the mediastinum Both types of tumors are encapsulated.

Lipoma This is a lobulated encapsulated tumor that contains fatty tissue and may occur in any part of the mediastinum When located in the superior mediastinum, it may extend up into the neck, and from the thorax it may penetrate the chest wall and present an hourglass extension under the skin.

Fibroma A tumor arising from fibrous tissue of the pericardium, pleura, or elsewhere may be found anywhere in the mediastinum. These tumors may reach huge size and may undergo sarcomatous change.

Myoma and Myxoma These are rare tumors but the few examples reported have been encapsulated.

Xanthoma This is another rare type of mediastinal tumor which is yellowish in color due to the presence of lipoid material. It is usually located in the costovertebral gutter and is encapsulated and easily separated from the neighboring structures

Osteochondroma Tumors composed of cartilage or bone and cartilage, are rare tumors which arise from cartilage or bone in the thoracic cage or possibly from the tracheobronchial tree. They grow slowly but may reach large size, and although they do not invade the neighboring structures they compress them and deformity of the thorax may be apparent. Sarcomatous change may take place in them.

Sarcoma This malignant tumor may arise from connective tissue or from a benign tumor in the mediastinum.

The tumor is often well encapsulated, and unless metastasis is present the nature of the tumor may be in doubt.

Carcinoma Metastatic involvement of the mediastinal glands from carcinoma of the bronchus or esophagus or other organs is common. The thymus gland is the most common site of primary carcinoma in the mediastinum.

THE ESOPHAGUS

Congenital Anomalies of the Esophagus

More or less complete atresia of the esophagus may be found in the newborn, but more commonly the condition is associated with tracheo-broncho-esophageal fistula In this condition the esophagus ends in a blind pouch at some point below the pharynx, and from this pouch a closed process or cord passes downward to the neighborhood of the trachea. The lower segment of esophagus is perfectly normal, but its upper end connects by a fistula to the trachea or to a bronchus

Perforation of the Esophagus

Penetrating wounds of the esophagus are usually caused by ingested foreign objects such as chicken bones but the esophagus may be torn by rough instrumentation such as the forcible passage of a stomach tube Leakage of esophageal contents into the superior or posterior mediastinum causes, unless treatment is instituted early a highly fatal mediastinitis

Stricture of the Esophagus

This may be congenital or acquired. In the latter case, it is often the result of swallowing lye but a type of esophageal stricture thought to be due to the regurgitation of acid from the stomach is occasionally seen

in the lower portion of the esophagus Simple chronic esophagitis may cause a stricture at any level

Cardiospasm

Stenosis of the esophagus at the esophageal hiatus is rather common and occasionally the condition may be so severe that surgery is necessary The esophagus may be enormously dilated and sinuous, and practically no food may be able to enter the stomach

Tumors of the Esophagus

A number of benign tumors occasionally occur in the esophagus. Adenoma may be seen in the form of a small polyp usually pedunculated and lipoma, fibroma, or leiomyoma may be encountered. Rhabdomyosarcoma, a rare malignant tumor has also been described

The only common malignant tumor of the esophagus is carcinoma, usually of the epidermoid variety although occasionally adenocarcinoma is seen. Carcinoma of the esophagus may be of the flat infiltrating type the large fungating type or the papillary type but any of these may grow upward or downward along the esophagus for a considerable distance The wall of the esophagus feels thickened and indurated, and there may be dilatation above the lesion. Metastasis takes place to the lymph nodes about the hilus of the lung and along the esophagus, and nodes just below the diaphragm are commonly involved by a growth in the lower two-thirds. Late metastasis involves the cervical chain of glands.

THE HEART

Pericardial Effusion and Purulent Pericarditis

Accumulation of excess fluid in the pericardial sac is a common condition. The fluid may be serous or purulent, both types producing heart temponade and the latter in addition causing the usual toxic manifestations of a purulent infection.

Wounds of the Heart

Most heart wounds are immediately fatal, but in some cases particularly in stab wounds, there may be a laceration of a ventricle only without too rapid loss of blood into the pericardial sac, and the patient may survive for a considerable length of time

Adhesive Pericarditis

In some cases of adhesive pericarditis, the pericardium may become so thickened that the rigid and even partly calcified pericardium produces a cardiac constriction that seriously interferes with heart action.

Patent Ductus Arteriosus

A persistent connection between the aorta and the pulmonary artery may produce symptoms of cardiac insufficiency and surgical treatment may be carried out.

TREATMENT AND TECHNIQUE

Infection of the Mediastinum

Unless the infection becomes localized, treatment may be confined to medical therapy with penicillin. If a primary focus is present in the neck or thorax, it should receive proper surgical treatment. With the formation of an abscess in the mediastinum, drainage is indicated. An abscess in the superior mediastinum can usually be drained through an incision in the neck similar to that used in thyroidectomy The ribbon muscles are retracted to each side, and access to the space is obtained by careful instrumental and digital dissection downward in the plane of the thyroid gland. The anterior mediastinum may be drained by an incision similar to that described under ligation of patent ductus arteriosus (page 185) A portion of a costal cartilage is resected at the appropriate level, an incision is made in the rib bed, the pleura is carefully retracted, and a curved hemostat is introduced into the mediastinal space. When the pus is located, one or two soft rubber drains are inserted. In cases of abscess of the anterior mediastinum in which no exploration is necessary the simplest method of drainage is through a burr hole in the sternum. Suppuration of the posterior mediastinum is best approached by posterior mediastinotomy

Posterior Mediastinotomy (*Sauerbruch*) A paravertebral incision (Figure 56A) is made about 3 or 4 cm lateral to the midline and centered at the level of the posterior mediastinal abscess. The skin and deep muscles are retracted enough to expose the posterior surface of three or four ribs and the vertebral transverse processes. About 5 cm. of these ribs are resected subperiosteally and the transverse processes are removed with bone biting forceps Starting in the bed of one rib the periosteum is incised and a periosteal elevator is insinuated between the periosteum and the underlying pleura. The separation thus begun is continued upward, downward and laterally until the intercostal muscle bundles containing the intercostal vessels can be lifted up and ligated even with the cut ends of the ribs. The intervening muscle bundles are cut off and removed, and separation is continued until the pleura can be retracted laterally (Figure 57) A curved hemostat is used very gently to locate the abscess cavity and one or two soft rubber drains are inserted.

Lilienthal's Method This type of posterior mediastinotomy may be used when a wider degree of exposure of the posterior mediastinal struc-

tures is desired It consists of a paravertebral incision with a lateral ex tension of its lower end (Figure 56B) After the posterior segments of the ribs have been removed or cut, a long intercostal incision is made below the lowest exposed rib and extended around to the posterior axil

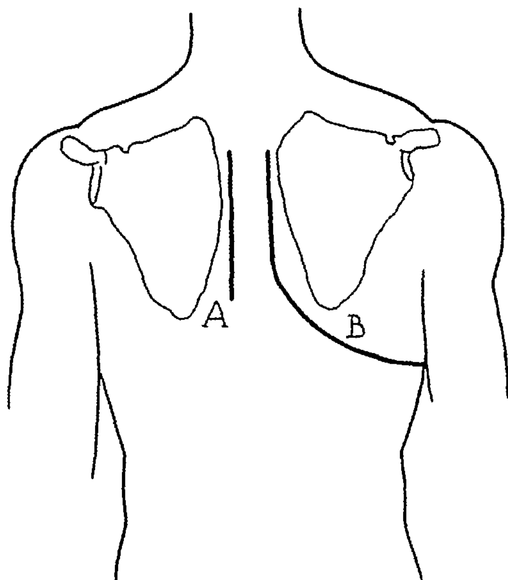


FIG. 56 A. Sauerbruch incision for posterior mediastinotomy B Lilienthal incision for posterior mediastinotomy

lary line, and the ribs are pulled upward. If desired, instead of an inter costal incision, the lowest exposed rib may be resected subperiosteally from the vertebral border to the posterior axillary line and the incision made in the rib bed. Lilienthal s mediastinotomy is the best type to use if a resection of the thoracic esophagus is to be attempted by a posterior approach. When the esophageal tumor is located at the level of or above the arch of the aorta, a right-sided incision is advisable; below that level a left-sided approach is used.

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Lilienthal's Method This type of posterior mediastinotomy may be used when a wider degree of exposure of the posterior mediastinal struc-

metastasis or unless the patient's general condition is such that he would not stand the operation Prostigmine in doses of 15 to 25 mg and atropine should be given preoperatively to patients with myasthenia gravis and should be continued or even increased during the early postoperative period. X ray treatment is palliative in some cases

A tumor of the thymus gland may be removed by a longitudinal incision extending from the level of the lower border of the cricoid cartilage to that of the fourth costal cartilage in the midsternal line The ribbon muscles are separated, and by blunt dissection beneath the manubrium of the sternum the pleura is pushed to each side Using Shumacher sternal shears, the sternum is split in the midline down to the third interspace and then to one side and the two portions are pulled apart. The pleura is carefully dissected from its under surface and pushed laterally and downward, and the sternal segments are held apart by a self retaining retractor The thymus gland may extend from the lower pole of the thyroid gland downward and laterally to the lower part of the pericardium and may be attached to the pericardium and to the ascending aorta. With careful protection of the pleura, the entire thymus and the tumor are removed by a combination of blunt and sharp dissection, ligating vessels as necessary The two halves of the sternum are brought together and held by encircling ligatures of silk or heavy catgut, the fascia is closed with catgut, and the skin with dermal.

Mediastinal Tumors Tumors of the posterior mediastinum may be approached through the posterior mediastinotomy of Sauerbruch or Lilienthal, or through an anterior transpleural approach with resection of a rib at the appropriate level as is described under ligation of patent ductus arteriosus (page 185) *but as a rule large mediastinal tumors* can be most satisfactorily removed by the posterolateral approach described under Pneumonectomy (page 147) This is of course, a transpleural approach and carries with it the possibility of infection of the pleural cavity but in practice it is difficult to remove a mediastinal tumor without accidentally opening the pleura, and the fact that the surgeon is more accustomed to this approach and has more room to work outweighs the disadvantage. After the pleural cavity has been opened and the tumor is located, the mediastinal pleura is incised over it and the mass is removed by a combination of blunt and sharp dissection. If a cystic tumor is present and cannot be completely removed, it may be aspirated or drained.

Tumors in the superior mediastinum are usually removable through a transverse cervical incision as described under drainage of an abscess of the superior mediastinum (page 170) If necessary the upper end of the sternum may be split in the midline and the bone cut through to one lateral border so that the two halves may be separated to give more room.

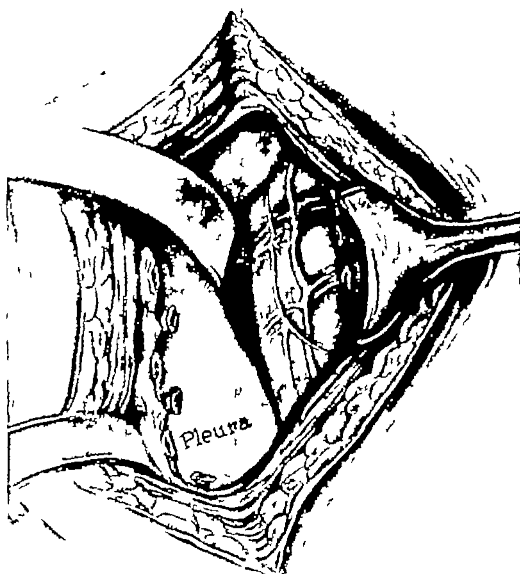


FIG. 57 *Posterior Mediastinotomy (Sauerbruch Incision)* A paravertebral incision has been made on the left side and segments of four or five ribs have been resected. The intercostal vessels have been tied, and the intercostal bundles removed The pleura is being retracted laterally

Tumors of the Thymus In a patient with myasthenia gravis unless a tumor can be demonstrated in the thymus the results of a thymectomy are so uncertain that the operation should be confined to those patients whose symptoms cannot be controlled by prostigmine. Thymectomy should be done if there is a tumor of the thymus, whether myasthenia gravis is present or not, unless the tumor appears to be inoperable because of its extension to the mediastinal structures or because of distant

Lipoma Fibroma Myoma and Myxoma These tumors are benign and encapsulated and should be removed Lipoma of the mediastinum may extend up into the neck or through the thoracic cage

Xanthoma These tumors are encapsulated and benign and should be removed usually by the posterolateral approach.

Osteochondroma Such a tumor of the thoracic cage should be removed if it is producing symptoms if small it should be kept under observation If it is increasing in size at all rapidly it should be removed A tumor that arises from the trachea or a bronchus should be removed if possible

Sarcoma The tumor should be removed if there is no evident metastasis, but few cures can be expected.

Carcinoma Primary carcinoma arising from the thymus should be removed if possible. Secondary carcinoma of the mediastinum is of course inoperable.

The Esophagus

Congenital Anomalies of the Esophagus The treatment of atresia depends on how much of the esophagus is absent Gastrostomy or jejunostomy is performed first and then the stomach is brought up and anastomosed to the upper stump in the thorax, or if this is not possible, a cervical esophagostomy is made.

When a tracheo-broncho-esophageal fistula is present, if a simple gastrostomy is done to feed the child, food regurgitates upward and into the bronchial tree and causes pneumonia To prevent this the stomach should be cut across at some point in its upper half the upper and lower segments closed by two layers of sutures and two gastrostomies made one in the lower portion of the stomach and one in the upper portion The lower gastrostomy is used for feeding and the upper permits the escape of esophageal and bronchial secretions. If the upper blind end of the esophagus reaches into the thorax, the next procedure is separation of the fistulous connection between the esophagus and bronchus or trachea by a transpleural approach, closure of the openings and anastomosis of the upper blind end of the esophagus to the lower segment, enlarging the esophageal hiatus by cutting the diaphragm enough to bring the stomach up into the pleural cavity as far as required. At a later operation the gastrostomies are closed and the two segments of stomach reunited If the upper segment of esophagus is not long enough to permit esophageal anastomosis the fistulous opening in the lower segment of the esophagus and in the trachea is closed and the lower end of the upper segment is brought out as an esophagostomy in the neck. Communication between the cervical esophagostomy and the lower gastrostomy is made by a rubber tube or if desired at a later period, a skin tube may be constructed as mentioned elsewhere in this chapter

Tumors of the anterior mediastinum are best exposed by resection of three or more costal cartilages, as described under the treatment of adhesive pericarditis (page 182) The flap of soft tissue is reflected laterally and if necessary a portion of the sternum may be rongeured away

Dermoid Cyst and Teratoma These anterior mediastinal tumors should be removed by the technique described for approach to the thymus gland (page 173) If the tumor is large, however a posterolateral transpleural approach is necessary If the tumor cannot be completely removed, partial removal and marsupialization of the remainder should be done

Lymphoma, Lymphocytoma, Lymphosarcoma, Leucosarcoma, and Hodgkin s Disease With the exception of the simple benign lymphoma, which can be removed, these tumors are inoperable.

Neurogenous Tumors These tumors should be removed by a posterolateral approach, resecting one or more ribs as required The tumor is separated from its attachments and nerve roots seen to be entering the tumor are widely excised. The capsule may be adherent to the lung or mediastinal structures if the lung is damaged it should be sutured with fine catgut Pleural effusion may be present with these or any large mediastinal tumor it is not necessarily indicative of malignancy When the tumor is of the hourglass type having a mass in the spinal canal and producing pressure on the spinal cord, along with the mass in the mediastinum, the portion of the tumor compressing the cord should be removed first by laminectomy As much as possible of the perivertebral portion is removed at the same time and in some cases a posterior mediastinotomy can be done and the tumor followed inward and removed *in toto* in a one-stage operation. This approach is not satisfactory unless the tumor is comparatively small For large tumors a posterolateral approach is advisable.

Bronchiogenic Cysts A bronchiogenic cyst of any size should be explored and removed if possible because of the difficulty of making a differential diagnosis without operation and because of the tendency for the cysts to become infected and to enlarge and produce pressure symptoms. Drainage of the cysts should be avoided, because of the likelihood of postoperative fistula resulting from a tracheobronchial communication.

Gastro-enterogenous Cysts Because of the frequency with which these cysts become infected and increase in size it is probable that they should be removed. When the entire cyst cannot be removed it may be partially excised and the remainder destroyed by cauterization.

Hemangioma and Lymphangioma These tumors should be removed if possible As both have a thin capsule dissection must be done very carefully Lymphangioma is likely to be associated with a supraclavicular extension and a two-stage operation may be required.

Tumors of the Esophagus and Carcinoma of the Stomach Benign tumors can usually be removed by means of an esophagoscope

The only treatment for carcinoma of the esophagus that offers a reasonable prospect of cure is surgical removal of the lesion. The transthoracic approach to carcinoma of the esophagus has made possible direct anastomosis of the stump of the esophagus to the stomach, and made unnecessary an extra thoracic connection between the cervical esophagus and the stomach by means of tubes of skin or loops of jejunum. The stomach has been anastomosed to the esophagus as high up as the arch of the aorta but the operation finds its greatest usefulness when the malignant lesion involves the lower third of the esophagus Carcinoma involving the cardiac end of the stomach can be approached with much less difficulty by the thoracic route than by the usual abdominal method. In fact, when the thoracic incision is enlarged downward across the costal cartilages and upper abdominal wall, this is the ideal approach for total gastrectomy

The usual posterolateral incision as described under Pneumonectomy (page 147) is made on the left side and the entire eighth rib is resected subperiosteally The pleural cavity is opened through the rib bed and a rib spreader is inserted. If the lesion is above the middle of the esophagus, the incision is extended upward between the scapula and the vertebral column, and the fifth, sixth, and seventh ribs are cut subperiosteally near their posterior attachments so that they may be retracted upward. The pulmonary ligament is cut and ligated, and the mediastinal pleura is incised over the esophagus from the diaphragm upward well above the tumor The lesion is palpated to ascertain whether it is movable and operable If it is decided that a resection is possible the phrenic nerve is crushed to paralyze the left side of the diaphragm. The blood supply of the esophagus comes largely from short vessels that arise from the aorta, these must be ligated as they are encountered. The esophagus is mobilized to a point 2 or 3 cm. above the lesion while traction is made on it, the peritoneal attachment at the diaphragm is cut. The finger is inserted in this opening and the diaphragm is incised from the esophageal hiatus to the attachment on the ribs. The inferior phrenic artery on the abdominal surface of the diaphragm will require ligation. Through the opening in the diaphragm, the abdominal cavity is thoroughly explored. The vagus nerves are cut and stripped away from the lower end of the esophagus. A large hemostat is applied to the esophagus near the gastro-esophageal junction, and a curved rubber-covered clamp is applied to the stomach below that point. The upper end of the stomach is cut in two between the clamps and the opening in the stomach closed, using a continuous suture of chromic catgut for the mucosa and a similar suture for the muscular and serous layers. This may be reinforced if desired by a series of interrupted silk sutures. The

Perforation of the Esophagus If a foreign object is present, an attempt should be made to remove it by esophagoscope but when a wide tear is seen in the esophagus, external drainage should be immediately instituted even though the foreign body has been taken out. When the perforation is in the neck, an incision should be made like that described for the removal of a pharyngeal diverticulum (page 93) The esophagus is exposed, and if a foreign body is present it is removed. An abscess cavity should be drained and the wound should be left open. No attempt should be made to suture the opening in the esophagus unless infection has not yet set in but a Levine tube should be passed into the stomach for feeding When the perforation is in the thoracic esophagus it should be exposed by posterior mediastinotomy on the left side for exposure of the lower esophagus and on the right side for the upper esophagus. A perforation of the upper part of the thoracic esophagus may be more directly approached by an incision transversely across the neck above the jugular notch. The sternum may be split if necessary as in the usual approach to the superior mediastinum.

Stricture of the Esophagus If the condition cannot be corrected by passing esophageal dilators, the narrowed portion of the esophagus must be resected and an anastomosis made between the upper stump and the stomach. The principle of this operation is the same as that described under carcinoma of the esophagus (page 177)

Cardiospasm If medication and dilatation are ineffective, esophagogastrostomy may be performed by either the abdominal or thoracic route. By the thoracic route the left eighth rib is resected subperiosteally the thorax is entered, the pulmonary ligament is cut and ligated, and the esophagus is mobilized The hiatus is enlarged by cutting the diaphragm enough to bring the fundus of the stomach up into the pleural cavity The fundus of the stomach is then anastomosed to the side of the dilated esophagus by the same method used in doing a pyloroplasty (page 362) except that here interrupted sutures are used. An incision on the esophageal wall is continued down onto the stomach, the incision is then opened up and sutured in a transverse direction, using interrupted sutures of silk in two or three layers At the conclusion of the operation, as much of the stomach is returned to the abdomen as is possible without placing tension on the suture line, and the diaphragm is sutured to the remaining portion of the stomach.

When the abdominal route is chosen — and this, although probably safer is more difficult — an upper midline incision or a transverse incision is made The left lobe of the liver is mobilized by cutting the lateral ligament and retracting it to the right, the esophageal hiatus is enlarged by cutting the diaphragm, and the esophagus is freed so that it can be brought down An anastomosis is then made between the fundus of the stomach and the side of the esophagus as described above.

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clamp is removed and the fundus of the stomach is grasped with two Allis forceps and pulled up through the diaphragm. The esophagus, which has been mobilized to a point above the level of the tumor is lifted up so that the fundus of the stomach can be approximated to its posterior surface A series of interrupted silk sutures is used to attach the muscular coat of the posterior side of the esophagus to the serous and muscular coat of the stomach. A rubber-covered clamp is applied to the stomach below the region of proposed anastomosis to prevent leakage when the stomach is opened continuous suction by means of a Levine tube in the esophagus prevents leakage from above. An opening is made in the stomach corresponding in size to the lumen of the esophagus, the esophagus is sectioned halfway through, and the mucosa of the stomach is approximated by a series of silk sutures to the mucosa of the esophagus Section of the esophagus is then completed, and the rest of its circumference is sutured to the opening in the stomach by similar interrupted silk sutures. This is followed by a series of interrupted sutures to bring together the muscular layer of the esophagus and the serous and muscular coat of the stomach. The stomach is fixed in position by a few sutures between it and the mediastinal pleura. A few sutures are also used to attach it to the pulmonary ligament. Interrupted silk sutures are inserted to attach the incised edge of the diaphragm to the stomach far enough below the level of the anastomosis to aid in relieving tension and at the same time prevent herniation of abdominal viscera through the diaphragm.

If the lesion in the esophagus is so high that the fundus of the stomach cannot be approximated to it without undue tension, the left gastroepiploic artery the short gastric vessels, and the gastrohepatic ligament with the left gastric vessels should be cut and ligated. It may also be necessary to cut a portion of the gastrocolic ligament on the left side. The left gastric artery should be cut close to the celiac axis to protect the collateral circulation. With this mobilization, the fundus of the stomach can be brought up to the top of the thoracic cavity and it still retains sufficient blood supply from the right gastric and right gastroepiploic arteries. Gastro-esophagostomy may be performed for all tumors that lie in the thorax and that leave enough normal esophagus above to make an anastomosis In upper esophageal tumors, the esophagus must be brought in front of the aortic arch before it can be sutured to the stomach. This is accomplished by cutting the esophagus in two above the lesion and pulling the upper stump up The esophagus is tied well above the lesion with two pieces of heavy silk and cut between the ties. The stumps are carbolized and then neutralized with alcohol. An incision is made in the mediastinal pleura above the arch of the aorta, and a curved hemostat is passed around the arch of the aorta and downward to grasp the ligature on the upper stump The stump is pulled upward

and around the arch a rubber-covered clamp is applied to it and the ligatured end is cut off to leave an untraumatized stump for suturing

In those cases in which the surgeon is unable to make an anastomosis between the esophagus and the stomach the dissection is continued upward into the neck through the superior mediastinum The end of the esophagus is covered with a rubber finger cot and pushed up into the tissues of the neck. After the thoracic wound has been closed the patient is placed on his back and by an incision parallel to the anterior left edge of the sternocleidomastoid muscle, the thyroid gland is exposed the lateral veins are ligated, and the gland is displaced to bring the cervical esophagus in view Traction on the cervical esophagus will draw the stump of thoracic esophagus up and out of the neck. The esophagus may be sutured to the skin incision at this point as the incision is closed, or it may be tunneled down subcutaneously and brought out through a stab wound on the chest at the level of the second left rib The esophagus should not be under tension and should project well beyond the skin margin, where it is held in place by interrupted sutures of silk. A gastrostomy is of course necessary

If an inoperable carcinoma of the upper stomach or lower esophagus is present with obstruction at this region the fundus of the stomach may be pulled up through the diaphragm and a lateral anastomosis made around the lesion between the side of the esophagus and the fundus. The principle of the anastomosis is the same as a gastro-enterostomy except that interrupted sutures of silk are used.

Transthoracic Partial Gastrectomy In performing this operation for carcinoma of the cardiac end of the stomach, after the esophageal attachments to the diaphragm have been freed and the diaphragm incised, the abdomen is thoroughly explored for metastases If none is found, the upper end of the stomach is mobilized by ligating the left gastric vessels, as many as necessary of the short gastric vessels and the gastrolienal ligament. The left gastric artery and vein are ligated well out into the lesser omentum and well below the level of the growth. The left gastro-epiploic vessels are similarly divided below the level of the tumor The stomach is pulled upward and divided between clamps leaving as much of the greater curvature as possible to facilitate the subsequent anastomosis The lower portion of the stomach is closed by two or three layers of sutures and the upper portion is covered with a pack and used to manipulate the esophagus The fundus of the stomach is pulled into approximation with the esophagus 2 or 3 cm. above the diaphragm, at this point the esophagus is anastomosed to the stomach by the method described above.

Transthoracic Total Gastrectomy This operation for extensive carcinoma of the stomach is best performed by a combined thoracic and abdominal approach. With the patient lying on the right side, a scratch

mark is made to indicate an incision along the entire course of the left eighth rib and then across the costal cartilage onto the abdomen, ending just above and lateral to the umbilicus The operation may be begun by making the abdominal part of the incision only If no metastasis is found and the lesion appears to be mobile and resectable, the incision is continued upward to the thorax. In the abdominal incision, the anterior rectus sheath is incised, the left rectus is retracted laterally and the posterior sheath and peritoneum are opened. For the thoracotomy the entire length of the eighth rib is resected subperiosteally and the thoracic cavity is entered through its bed. The costal cartilage is cut with rib shears, and no significant bleeding is usually encountered. The esophageal attachments are freed at the diaphragm and the diaphragm is cut from the esophageal hiatus to the ribs. The stomach is mobilized, cut off just below the pylorus and the duodenal stump is closed as described in the chapter on The Stomach. Mobilization of the stomach is continued upward to the esophagus and about 4 cm. above the diaphragm, at which point the esophagus is severed between rubber-covered clamps and the stomach removed. The transverse colon and greater omentum are pulled up and the root of the transverse mesocolon is exposed. The first loop of jejunum is identified, an opening is made in a bloodless area of the mesocolon, and the jejunum is drawn through. A rubber-covered clamp is applied to the side of the jejunum, and the side of the jejunum is anastomosed to the end of the esophagus by the same principle used in gastro-enterostomy All the sutures should be of interrupted silk and a third reinforcing row of sutures should be inserted. If the jejunal loop is under too much tension, this may be relieved to a great extent by cutting a few of the largest vessels in the mesentery which can be safely done if the arrangement of the vascular loops is studied. After the anastomosis has been completed, an entero-anastomosis should be performed between the ascending and descending loops of the jejunum, and the jejunum should be sutured to the mediastinal pleura, the pulmonary ligament, and the opening in the transverse mesocolon. It is well to introduce a de Pezzar catheter through a stab wound in one of the lower intercostal spaces to provide continuous suction drainage in the postoperative period. The opening in the diaphragm is sutured by two layers of interrupted silk sutures, a few sutures are placed between the diaphragm and the jejunal loops, and the abdominal and thoracic wounds are closed as usual.

The Heart

Pericardial Effusion and Purulent Pericarditis Aspiration of the pericardial cavity may be performed by inserting a large-caliber needle into the pericardium through the sixth intercostal space close to the sternum. The fifth intercostal space may be used if necessary Penicillin therapy is

valuable and penicillin should be injected into the pericardial sac after the aspiration of pus

Wounds of the Heart The heart may be exposed by the method described under adhesive pericarditis (page 182) and a small wound of a ventricle may be successfully sutured If the wound is in another chamber or in a great vessel, suturing may sometimes be performed but with

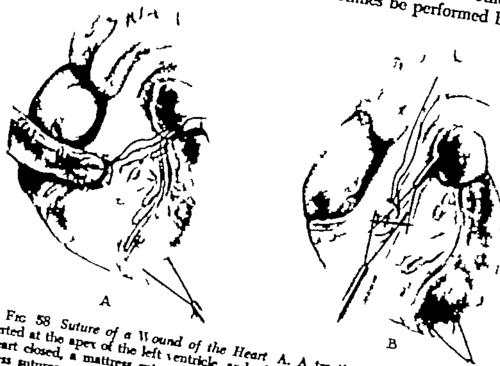


FIG 58 *Suture of a Wound of the Heart* A. A traction suture has been inserted at the apex of the left ventricle and while a finger keeps the wound in the heart closed, a mattress suture is being placed on each side of it. B The mattress sutures are used to hold the wound together while a series of interrupted sutures are inserted. The mattress sutures and the suture at the apex will be removed at completion of the operation.

more difficulty When the pericardium is exposed, it is usually distended with blood and blood may have infiltrated throughout the anterior mediastinum. The pericardial wound is located and rapidly enlarged, and the heart is lifted up. Blood will be seen coming out of the wound. With the heart grasped in the hand, pressure is made with the thumb or finger over the opening to control the hemorrhage while a stay suture of silk is inserted into the apex of the left ventricle (Figure 58) While tension is made on this, a finger is used to close the wound in the heart, while a mattress suture of silk is placed in the heart muscle on each side of the finger These sutures should not penetrate the endocardium but should go deeply into the muscle. The finger is removed and the wound edges are held together by crossing the ends of the sutures and making tension on them while a series of interrupted sutures are inserted to close the wound (Elkin's method) The mattress sutures and the stay suture are removed when the suture line is completed.

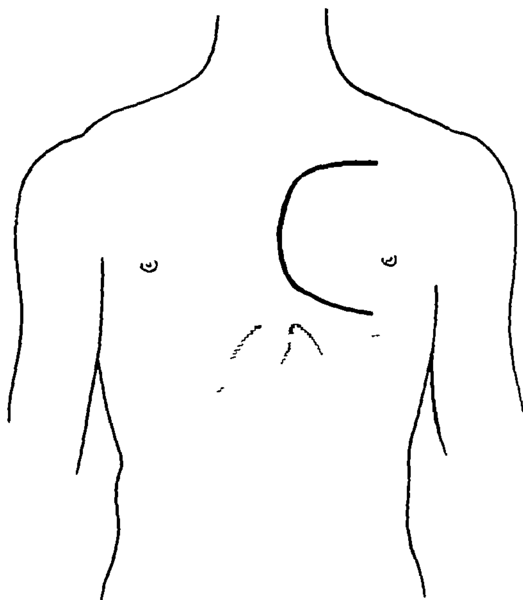


Fig 59 Incision for Exposure of the Heart.

If the wound is in an atrium or in a great vessel an attempt should be made to close it with interrupted sutures of fine silk, the vessel or atrium being occluded at intervals by pinching it as each suture is put in.

If the heart should cease to beat during the operation, adrenalin may be injected into the ventricle or atrium, and the heart should be rhythmically compressed in the hand until contractions are resumed. The pericardial sac is washed out with normal saline solution and the opening is closed with interrupted sutures of silk or catgut. Dicumarol should be administered postoperatively

Adherent Pericarditis A curved incision is made with the convexity over the left side of the sternum and centered at the level of the fourth costal cartilage (Figure 59) A flap consisting of skin, subcutaneous tissue and pectoral muscle is turned back laterally to expose the third,

fourth, and fifth costal cartilages as far as their junction with the ribs These cartilages are resected subperichondrially throughout their length and removed. The internal mammary vessels are located in the upper and lower portions of the wound clamped cut and ligated. The inter costal muscle bundles are ligated and cut just lateral to the sternum and a flap consisting of the intercostal muscles and the perichondrium is turned laterally If necessary a semicircular section may be removed

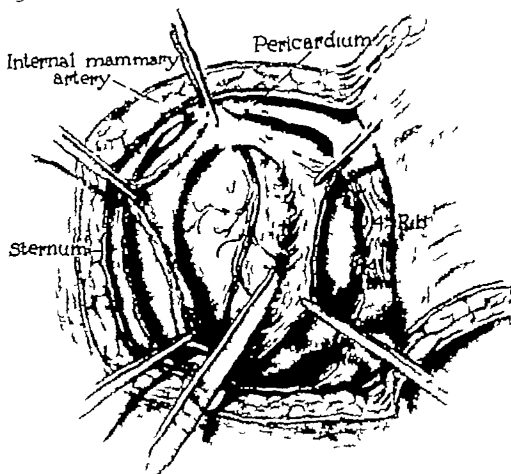


FIG. 60. *Removal of Pericardium for Adhesive Pericarditis* A flap of skin and muscles has been turned laterally The costal cartilages and, if necessary part of the bone of the third, fourth, fifth, and sixth ribs have been resected, the inter costal bundles ligated and removed, and a part of the sternum rongeured away after ligation of the internal mammary vessels The pericardium has been opened and is being separated from the heart.

from the lateral edge of the sternum with rongeur forceps and the sixth costal cartilage may also be resected to give additional room Pleural reflections are separated from the pericardium and retracted laterally and the pericardium is thoroughly exposed (Figure 60) The thickened

pericardium is lifted up with forceps and an incision is made th over the left ventricle. An attempt is made to find a cleavage p tween the pericardium and muscle when this is established, by bination of blunt and sharp dissection the pericardium is stripp from the anterior surface of the heart, using particular care to a coronary vessels that may be adherent to the pericardium. The nerves should be noted and avoided, by stripping them off the dium and pulling them aside The left ventricle having been fr dissection continues around to the right ventricle and then up *auriculoventricular groove. In some cases the pericardium is*

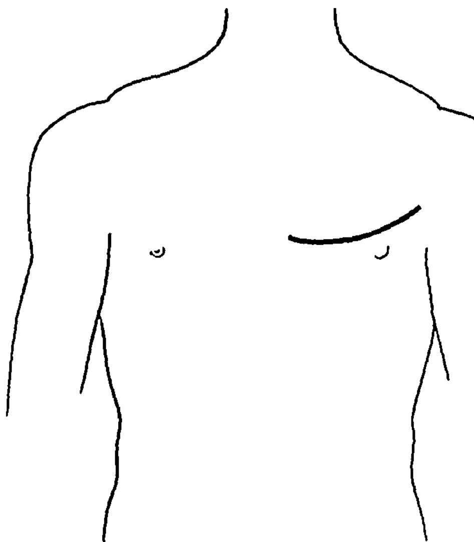


Fig. 61 Incision Used for Anterior Approach to the Thoracic Cavit

and it may be necessary to use bone-biting forceps to cut it. The p dial sac should not be removed until the dissection has proceed enough to make sure that it will not be needed to cover a wound

should be sutured over it in the form of a patch. At the conclusion of the operation or after as much dissection has been done as possible the flap of intercostal muscles is returned to its place and sutured to the remaining muscle in the intercostal spaces above and below The flap of skin and pectoral muscle is then replaced, a layer of catgut sutures is placed in the muscle, and the skin is closed with dermal.

Patent Ductus Arteriosus An incision is made over the third left costal cartilage and rib extending from the edge of the sternum to the anterior axillary line (Figure 61) The pectoral muscles are divided and the third rib and cartilage are removed subperiosteally throughout the length of the incision. The rib bed is incised the pleura is opened, and the ribs are held apart with one or two Tuffier rib spreaders If exposure is found to be insufficient, the second costal cartilage may be divided and the rib spreader opened wider The arch of the aorta is located and an incision is made through the mediastinal pleura below the arch

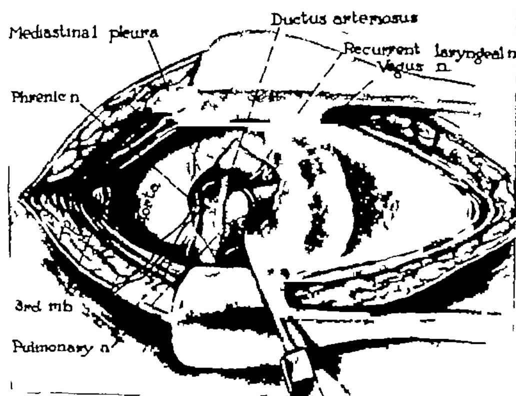


Fig 62 *Ligation of Patent Ductus Arteriosus* Through an anterior approach the third rib has been resected and the thoracic cavity entered. The mediastinal pleura has been incised and a ligature is being passed around the ductus.

and posterior to the phrenic nerve. The ductus lies between the aortic arch and the pulmonary artery near the region of origin of the left subclavian artery and the recurrent laryngeal nerve passes around the aortic arch a few millimeters posterior to the ductus. When the ductus is

pericardium is lifted up with forceps and an incision is made through it over the left ventricle. An attempt is made to find a cleavage plane between *the pericardium and muscle when this is established,* by a combination of blunt and sharp dissection the pericardium is stripped away from the anterior surface of the heart, using particular care to avoid the coronary vessels that may be adherent to the pericardium. The phrenic nerves should be noted and avoided by stripping them off the pericardium and pulling them aside The left ventricle having been freed, the dissection continues around to the right ventricle and then up to the auriculoventricular groove In some cases the pericardium is calcified

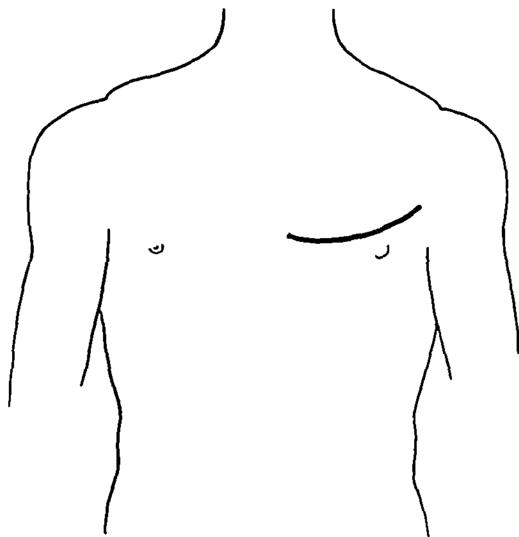


FIG. 61 *Incision Used for Anterior Approach to the Thoracic Cavity*

and it may be necessary to use bone-biting forceps to cut it The pericardial sac should not be removed until the dissection has proceeded far enough to make sure that it will not be needed to cover a wound in the ventricle If such a wound should be made, a portion of the pericardium

should be sutured over it in the form of a patch. At the conclusion of the operation or after as much dissection has been done as possible the flap of intercostal muscles is returned to its place and sutured to the remaining muscle in the intercostal spaces above and below The flap of skin and pectoral muscle is then replaced a layer of catgut sutures is placed in the muscle and the skin is closed with dermal.

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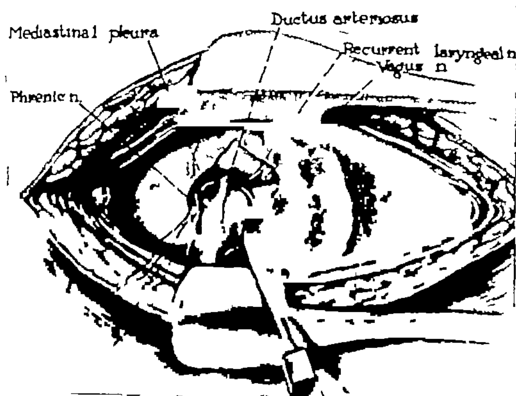


FIG. 62. *Ligation of Patent Ductus Arteriosus.* Through an anterior approach the third rib has been resected and the thoracic cavity entered. The mediastinal pleura has been incised and a ligature is being passed around the ductus.

and posterior to the phrenic nerve. The ductus lies between the aortic arch and the pulmonary artery near the region of origin of the left subclavian artery and the recurrent laryngeal nerve passes around the aortic arch a few millimeters posterior to the ductus. When the ductus is

located, this may be confirmed by making pressure on it and causing disappearance of the thrill that is so pronounced over the heart. Dissection of the areolar tissue in the region of the ductus should be very carefully conducted, particularly on the posterior surface because here the ductus is most easily torn. An aneurysm needle carrying two pieces of fairly heavy silk is passed around the ductus and these are tied as far apart as possible (Figure 62) Unless the vessel is soft and friable, or very short, it should be cut in two between the ligatures. The opening in the mediastinal pleura is sutured with fine catgut, the rib spreader is removed, and three or four temporary silk ligatures are placed to hold the ribs together while the pleura and intercostal muscles are closed in two layers. A few stitches may be inserted to bring the split pectoral muscle together and the skin is closed with dermal.

Vagotomy

The indications and contra indications for this operation and the relative merits of the abdominal and thoracic approaches are discussed in the chapter on The Duodenum. From the esophageal plexus at the bifurcation of the trachea, the right and left vagus trunks pass downward along the esophagus. As a rule, the right vagus lies on the dorsal surface of the esophagus and the left on the ventral surface each is from 1 to 2 mm in diameter Small intercommunicating branches pass between the main trunks either in front of or behind the esophagus. There are many variations in the foregoing distributions The main trunks may not form until a short distance above the diaphragm and in some cases not at all, fine filaments passing irregularly through the esophageal hiatus There is considerable variation in the position of the right and left nerves and there may be one main trunk in front or behind the esophagus, the other trunk represented only by small intercommunicating nerve filaments

To perform a transthoracic vagotomy a posterolateral incision is made on the left side the eighth rib may be resected subperiosteally or the thorax may be opened through the eighth intercostal space. The pulmonary ligament is clamped and cut, and the mediastinal pleura is incised over the esophagus. If a Levine tube has been previously inserted, it simplifies identification of the esophagus The esophagus is mobilized for a distance of about 5 cm., starting a short distance above the diaphragm, and the esophagus in this region is freed in its bed so that it can be rotated. The vagus nerves can easily be seen and when slight tension is made on the esophagus they can be felt as firm inelastic threads A little procaine hydrochloride is injected into the nerve trunks with a fine hypodermic needle, and 3 or 4 cm of each trunk and all the filaments that can be located are excised. The proximal ends of these are lifted out so that as the mediastinal pleura is closed by a running

suture of fine catgut the pleura can be arranged to fold over and enwrap them The thoracic wall is closed as described in the chapter on The Lung and Pleura.

POSTOPERATIVE CARE

Transfusions are given freely and fluid balance is maintained by parenteral glucose and saline. Penicillin is given intramuscularly or intra venously every three hours for several days. If a catheter has been placed in the thoracic cavity suction is maintained on it continuously At the end of forty-eight hours there is usually so little drainage that the tube can be removed and a tight dressing is applied over the opening so that air cannot enter the chest. The stomach or jejunum should be kept empty by suction or an indwelling Levine tube until fluids can be taken by mouth. Following an operation on the esophagus, fluids are given by mouth on the third postoperative day this is gradually increased until parenteral fluids are no longer necessary Soft foods are given at the end of a week. Oxygen therapy is given for cyanosis and bronchoscopic aspiration of mucus may occasionally be necessary Postoperative suppurative mediastinitis or empyema may require drainage.

CHAPTER X

The Abdominal Wall

CHAPTER X

The Abdominal Wall

PREOPERATIVE PREPARATION

LESIONS OF THE ABDOMINAL WALL
- Congenital Anomalies
- Injury of the Abdominal Wall
- Tumors of the Abdominal Wall
- Inflammation
- Obesity
- Hernia

TREATMENT AND TECHNIQUE
- Congenital Anomalies
- Injury of the Abdominal Wall
- Tumors of the Abdominal Wall
- Inflammation
- Obesity
- Hernia
- Abdominal Incisions

POSTOPERATIVE CARE

The Abdominal Wall

PREOPERATIVE PREPARATION

When a patient with a hernia is very much overweight, he should be put on a rigid diet and the condition corrected before operation is performed. An acute upper respiratory infection or a cough should be relieved before surgery is undertaken If a strangulated hernia is present, normal saline solution should be given intravenously to restore the lost fluid and chloride if there is vomiting, the stomach should be kept empty by continuous suction during the operation and after the operation until peristalsis is established.

LESIONS OF THE ABDOMINAL WALL

Congenital Anomalies

Exomphalos· Herniation of viscera into the umbilical cord is sometimes seen in the newborn. Small bowel is usually present in the cord, but there may be a huge mass containing small bowel large bowel part of the liver or the stomach. The vitelline membrane that covers the sac soon becomes necrotic and death may result from peritonitis.

Exstrophy of the Bladder· This defect of the lower abdominal wall with protrusion of the urinary bladder is discussed in the chapter on The Bladder and the Prostate

Cyst and Fistula of the Vitelline Duct Persistence of the vitelline duct may result in Meckel's diverticulum, a blind pouch projecting from the ileum, which is discussed under the ileum (page 379) When the external portion of the duct does not disappear a cyst or fistula occurs, the latter discharging into the umbilicus. If the complete duct between the ileum and the umbilicus persists there is a fecal fistula

Patent Urachus· Persistence of the duct connecting the urinary bladder with the allantois may cause a cyst or fistula. The fistula may be connected with the bladder and discharge urine but more commonly there is an incomplete tract, which becomes infected and discharges pus.

Injury of the Abdominal Wall

A direct blow on the abdomen may produce hemorrhage and ecchymosis or a hematoma, and infection of the latter may result in an abscess. Rupture of a muscle, particularly the rectus abdominis, may be caused by direct violence but may also result from muscular effort. There is retraction of the torn ends of the muscle and swelling due to hemorrhage. Any severe blow on the abdomen and any penetrating wound may be associated with visceral injury and peritonitis.

Tumors of the Abdominal Wall

Lipoma frequently develops in the fatty tissue of the abdominal wall, and the usual benign tumors of the skin may occur on the abdomen. Desmoid, a fibromatous tumor that arises in the rectus muscle and has some tendency to local recurrence if not completely removed, is a round, more or less encapsulated tumor, more likely to be seen in women. Sebaceous and dermoid cysts may be encountered on the abdominal wall as elsewhere.

Malignant tumors are fibrosarcoma developing from the connective tissue of the abdominal wall, and epidermoid carcinoma, which is most likely to occur in the region of the umbilicus. Intra-abdominal malignant tumors may spread through the lymphatics in the region of the umbilicus to form a mass in that region.

Inflammation

Primary infection of the abdominal wall may result from a wound or an infected sweat gland or hair follicle. There is little tendency for the infection to enter the peritoneal cavity but it may spread over the entire abdomen. Infectious gangrene of the skin is commonly seen in this location and will be discussed in the chapter on The Skin and Subcutaneous Tissue. Subcutaneous abscess often results from an intraperitoneal infection. An appendiceal abscess may present under the skin in the right lower quadrant. I have opened two subcutaneous abscesses in the upper abdomen, which were caused by inflammation and rupture of the gallbladder.

Excoriation of the skin due to a high intestinal fistula is often seen and is very difficult to treat.

Obesity

In some cases after an obese patient has reduced by diet, there remains a fatty apron of abdominal wall that hangs down over the pubis and constitutes an actual deformity. Maceration and ulceration in the moist folds of skin are common.

Hernia

Hernia is the abnormal protrusion of a viscus through a normal, anomalous or acquired opening. Abdominal hernias may be internal or external, the former consisting of such hernias as those through the foramen of Winslow or the fossa of Treitz, which are discussed in the chapter on The Jejunum and Ileum External hernias, according to their location, may be classified as inguinal, femoral, umbilical epigastric, ventral, or incisional. Femoral hernia is not a rupture through the abdominal wall, but for convenience will be considered here along with the rare hernias in the sciatic, obturator lumbar and perineal regions Hernias may also be classified as reducible or irreducible (incarcerated) depending on whether the contents can be returned to the abdomen by manual pressure. When the neck of the sac is so tight that it interferes with circulation to the protruded viscus the hernia is said to be strangulated and in most cases is irreducible. Occasionally prolonged manipulation may bring about the reduction of a strangulated hernia, and bowel, which may be nonviable is returned to the abdomen. The contents of hernia, sac usually consist of omentum or small bowel, but the large bowel or the bladder are not infrequently encountered. When part of the diameter of a section of small bowel, usually the ileum, is incarcerated in the neck of the hernial sac, it is known as Littre s hernia. When a viscus, such as the ascending or descending colon or the bladder which is not entirely covered by peritoneum, passes down into a hernia, the bare surface of the bowel or bladder is not enclosed in a peritoneal sac, since the peritoneum is reflected off the viscus on each side of the bare area. This is known as a sliding hernia. Sliding hernia most commonly occurs in the inguinal and femoral regions. The surgeon must be constantly on his guard lest he be dealing with one, since if one side of what appears to be the sac of the hernia is picked up and opened, the incision may enter the bowel or bladder If the other side is opened, as should properly be done, one enters the hernial sac and finds the bowel or bladder making up part of the wall of the sac.

Inguinal Hernia There are two kinds of inguinal hernia, the direct and the indirect. In the indirect type the hernial sac emerges at the internal abdominal ring and passes downward within the substance of the spermatic cord where it is covered by the infundibuliform and cremasteric fasciae. The sac is located on the anterior aspect of the cord, where it is visible as a whitish membrane after the cremasteric fascia has been incised Because the testis in its descent takes a peritoneal investment with it, the tunica vaginalis there is apt to be a preformed sac in the upper part of the inguinal canal, the funicular process, into which herniation takes place- in some cases the vaginal process may be patent throughout its entire course down to the testicle. There is reason to be-

lieve that a preformed funicular process contributes to the formation of indirect inguinal hernia in almost all cases Partial obliteration of the tunica vaginalis in its midportion may result in a hernia above and hydro cele below Indirect inguinal hernia is often seen in association with un descended testicle and in this condition the rare form of hernia inter stitial hernia, is encountered The hernial sac, instead of passing down the inguinal canal, goes upward in the abdominal wall between the ex ternal oblique aponeurosis and the internal oblique, and in this position it may become strangulated Indirect inguinal hernia may occur in the female but is much less common than in the male. The herniation then oc curs into the canal of Nuck and the sac passes down the canal in close relation to the round ligament.

Direct inguinal hernia is a hernia through the floor of Hesselbach s triangle medial to the deep epigastric artery The peritoneal sac pushes the transversalis fascia in front of it and has less tendency to enter the scrotum. The hernial protrusion is usually a rather wide bulge which is seen when the cord is lifted up In the usual hernia there is little diffi culty in diagnosing the type after examining the patient. In fact, mere inspection of the inguinal region when the patient coughs is often suffi cient to make a diagnosis. The globular protrusion of a direct inguinal hernia, which bulges the abdominal wall directly outward, is easily dis tinguishable from the more oval swelling that tends to pass downward, seen in indirect hernia. In direct inguinal hernia, the external abdominal ring is always enlarged, in indirect inguinal hernia there may be no enlargement of the external abdominal ring until the hernia is complete – that is, until it has passed through the inguinal canal. When this occurs the examining finger will feel the sac entering the upper part of the scrotum when the patient coughs In direct inguinal hernia a weakness may be felt in the posterior abdominal wall at the level of the external ring These differential points, as has been stated, make diagnosis in many cases relatively easy but in others it may be difficult or impossible to tell whether one is dealing with a direct or indirect hernia until the structures are surgically exposed. The deep epigastric artery cannot be pal pated except at operation and is of no value in classifying the hernia preoperatively Coexisting direct and indirect inguinal hernias are often seen.

Femoral Hernia A hernia through the femoral canal is seen more often in women than in men, but even in women it is much less com mon than inguinal hernia. The femoral sheath contains three compart ments, the lateral one for the femoral artery the middle compartment for the femoral vein, and the medial compartment, the femoral canal, containing areolar tissue. It is through this that the hernial sac descends to present below the inguinal ligament in the medial aspect of the thigh. The neck of the sac of a femoral hernia is always located lateral to the

pubic tubercle, and the sac emerges through the fossa ovalis being covered by the superficial fascia and the skin. In many cases the sac passes upward and lies on the surface of the external oblique aponeurosis above the inguinal ligament, where it may be mistaken for inguinal hernia. So many of the cases of femoral hernia occur in obese patients that the diagnosis is much more difficult than would be anticipated. The sac may be so small as to be obscured by fat, the location of the inguinal ligament may not be easy to determine pulsation on coughing is not a constant finding, and reduction of a femoral hernia is not as easily accomplished as reduction of an inguinal hernia.

Umbilical Hernia Herniation of abdominal contents into the umbilicus is very common in infancy and is met with not infrequently in the adult, particularly when there is obesity and diastasis of the rectus muscles Omentum is usually found in the sac, but in the larger hernias small bowel may be encountered.

Epigastric Hernia Herniation through the midline at some point between the umbilicus and ensiform cartilage is commonly seen. Associated with a hernia in this location particularly a lipoma is encountered which apparently develops in the preperitoneal tissue, protrudes outward through the fascia, and, by dragging a funnel of peritoneum with it is responsible for the hernia.

Ventral Hernia This term is applied to any hernia of the abdominal wall except those which have more specific titles. A common site for ventral hernia is in the lower midline but herniation in the linea semilunaris or elsewhere may be encountered.

Incisional Hernia This is a form of ventral hernia that occurs at the site of an operative incision. Drainage infection of the wound, inadequate closure, coughing during convalescence defective suture material, and poor abdominal musculature all predispose to the condition. The hernial opening may be very large with omentum and several loops of bowel in the sac, but because of the large opening strangulation is rare. Intrasacular adhesions and loculation of the sac are common.

Obturator Hernia This type of hernia, which is more often seen in women past the age of fifty is a protrusion of the abdominal viscera through the opening by which the obturator nerve and vessels pass out of the pelvis The sac may appear above or below the obturator internus muscle and is covered by the pectineus and the adductor brevis. A mass should be sought for on the medial side of the thigh when the leg is rotated outward and the thigh is flexed, and rectal or vaginal examination may help in confirming the diagnosis. Many of the cases are recognized only when an abdominal operation is performed for intestinal obstruction and a loop of bowel is found to have passed through the obturator hiatus.

Lumbar Hernia This is a hernia through the lumbar triangle of Petit, which is bounded by the external oblique in front, the latissimus dorsi behind, and the crest of the ileum below The mass is usually easily reduced and an impulse is felt on coughing

Sciatic Hernia Herniation may occur through the greater or lesser sciatic notch, with the sac presenting above or below the pyriformis muscle.

Perineal Hernia Herniation may occur through the pelvic diaphragm into the perineum, the sac following the rectum, the vagina, or the urethra.

TREATMENT AND TECHNIQUE

Congenital Anomalies

Exomphalos An incision should be made into the cord and the viscera that have herniated should be returned to the abdomen. If necessary the umbilical opening should be enlarged so that this can be done Any umbilical vessels containing blood should be carefully caught and tied, the sac and cord excised, and the wound closed using continuous sutures of catgut for peritoneum, fascia, and muscles, and dermal suture for the skin.

Cyst and Fistula of the Vitelline Duct and Patent Urachus If a fistula is present that discharges fecal material, it is due to persistence of the vitelline duct. If the fistula discharges urine, it is due to a patent urachus In many cases an incomplete fistulous connection is present and there is only an intermittent mucous discharge. If the application of silver nitrate to the tract does not cure the condition, surgical excision will be necessary In most cases it will be necessary to remove the umbilical ring at the same time. A probe should be inserted into the tract to outline its course and the fistula should be dissected out. If the tract extends to the bladder or bowel, it should be cut off at that level and the opening in the viscus closed. Otherwise the tract should be followed as far as possible and excised together with any cyst that may be present. The abdominal wall should be closed in layers by the usual technique.

Injury of the Abdominal Wall

Hematoma of the abdominal wall may require aspiration, and an abscess may require drainage Hernia may occur as a result of rupture of the rectus muscle and may require later repair Penetrating wounds of the abdominal wall nearly always require abdominal exploration to rule out injured viscus.

Tumors of the Abdominal Wall

A tumor of the abdominal wall, unless it is a small benign tumor of the skin or a metastatic malignant nodule, should usually be excised.

In removing a primary malignant tumor or a large desmoid, it may be necessary to sacrifice a good deal of the abdominal muscle. In this case it is advisable to use strips of fascia lata to reinforce the closure.

Inflammation

Primary infection of the abdominal wall should be treated the same as an infection elsewhere If there is a localized collection of pus, it should be drained. The intra abdominal abscess that communicates with a subcutaneous one should be gently explored if any foreign bodies, such as fecoliths or gallstones, are found they should be removed, if this can be done without breaking through the wall of the abscess. Excoriation of the skin by the discharge from a high intestinal fistula should be treated by protecting the skin against the discharge as much as possible Continuous suction should be arranged in such a way as to withdraw the discharge before it has a chance to accumulate on the abdominal wall. The skin should be coated with zinc oxide ointment containing aluminum powder

Obesity

A pendulous fatty abdominal wall that cannot be relieved by diet and that is causing distress to the patient may be excised by removing an elliptical segment of skin and fat from the lower abdomen. The incision should extend from one side of the abdomen to the other beginning just above the anterior superior spine of the ileum. The abdominal wall should be lifted up in the hand in order to estimate the correct amount of tissue that should be removed. In some cases the umbilicus will be included in the resection The skin and fat should be brought together by a series of interrupted sutures of silkworm gut and a continuous suture of dermal. Two Penrose drains should be left in the wound for forty-eight hours.

Hernia

Indirect Inguinal Hernia Inguinal hernia, whether direct or indirect, should be repaired unless it is so large that the contents have forfeited the right of domicile in the abdomen or unless the age or physical condition of the patient prohibits the operation. In children the operation should be postponed if possible until the child is past the diaper wearing age Herniorrhaphy can be conveniently combined with an operation for hydrocele or varicocele, but if there is a large hydrocele sac it may be necessary to aspirate the contents before the sac can be delivered into the inguinal incision. The testicle is pushed upward so that the tunica vaginalis can be seen in the incision, and an aspirating needle is inserted. When an appendectomy is necessary for chronic appendicitis, and a herniorrhaphy is being done on the right side, in some cases after the

hernial sac has been opened the cecum and appendix, or the appendix alone can be grasped and drawn through the opening and an appendectomy performed In many cases however the incision in the skin and external-oblique aponeurosis must be extended a short distance farther laterally so that the internal-oblique and transversus fibers can be split a few centimeters lateral to the internal abdominal ring and the peritoneum entered at this point. The split muscles are retracted as in a McBurney incision (page 217) After the peritoneum is opened the cecum will be found only a short distance away

Technique of Repair of Indirect Inguinal Hernia The internal or deep abdominal ring lies midway between the anterior superior spine and the spine of the pubis The incision should extend parallel to and one finger's breadth above the inguinal ligament down to the pubic spine (Figure 63)

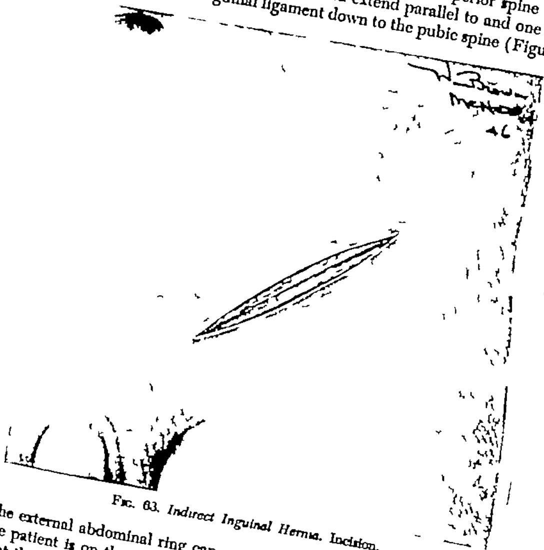


FIG. 63. *Indirect Inguinal Hernia. Incision.*

The external abdominal ring can usually be felt without difficulty when the patient is on the table, and it is helpful to locate it by palpation so that the incision will be centered toward the midpoint of the ring. The skin and superficial fascia are incised, and bleeding vessels, usually in

Fig. 64. *Indirect Inguinal Hernia.* The external-oblique aponeurosis and the external ring are exposed.

Fig. 65. *Indirect Inguinal Hernia.* The aponeurosis of the external oblique has

the lower angle of the wound, are caught and tied. Fat and fascia are cleaned off the aponeurosis of the external oblique by gauze stripping until the external abdominal ring is clearly exposed (Figure 64) A small incision is made in the external-oblique aponeurosis each edge of the incision is caught with a hemostat, and the aponeurosis is incised in the line of the incision from the internal abdominal ring to the apex of the

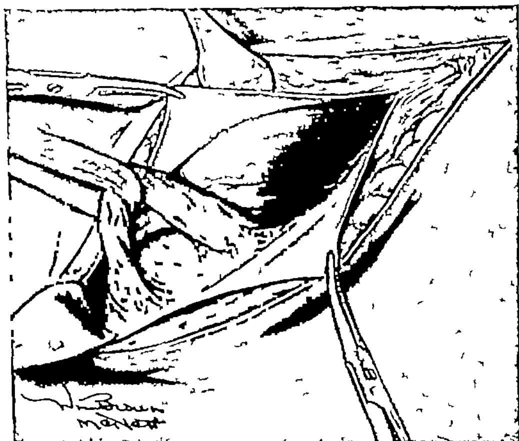


FIG. 66. *Indirect Inguinal Hernia* The cord has been freed and lifted up

external abdominal ring (Figure 65) The ileoinguinal and ileo-hypogastric nerves should be watched for and avoided. The lower flap of the external-oblique aponeurosis is freed down to the inguinal ligament, and the upper flap is separated from the internal oblique for a short distance. The cord lies on the transversalis fascia between the lower margin of the internal oblique and the upper edge of the inguinal ligament, and a finger following down the external-oblique aponeurosis to the inguinal ligament, is hooked around the cord and it is pulled up Thin fascial attachments that hold the cord to its bed are snipped as necessary to free it, and a piece of gauze or tape is passed around the cord and held with a hemostat (Figure 66) When the cord is lifted up if a direct hernia is present it will be seen as a bulging of the transversalis fascia, in the place formerly occupied by the cord. The spermatic cord is usually

about the size of the little finger and any excessive increase in its diameter is usually evidence that a hernial sac extends down into its substance The sac of an indirect hernia is covered by cremasteric and infundibuliform fascia, and these structures are picked up at one point on the cord, incised, and split the length of the cord. If a hernial sac with its whitish

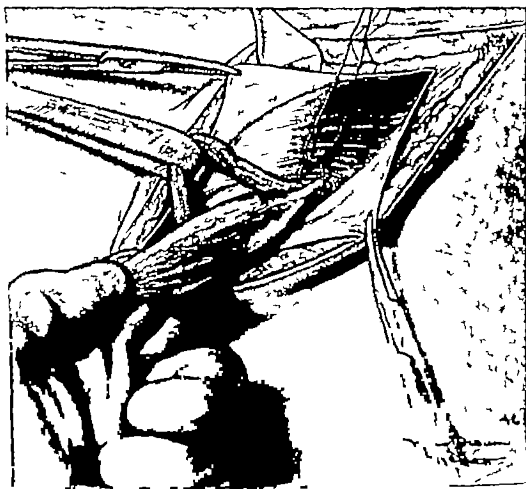


FIG. 67 *Indirect Inguinal Hernia.* The sac has been separated from the cord and its neck is being ligated.

color is not seen at the level where the cord is being inspected, search should be made for it about 2 cm. below the internal abdominal ring The sac lies in front of and somewhat above the other cord structures. When identified it is caught by two hemostats and carefully opened between them The opening is enlarged so that the inside of the sac can be inspected, and omentum or bowel which is present in the sac is pushed back into the abdomen with dressing forceps where it is held if necessary by inserting the end of a sponge into the neck of the sac. The index finger is inserted into the distal part of the sac, and as the sac is lifted up, by a combination of gauze stripping and careful sharp dissection it is freed. The vas, which can easily be recognized by its

hardness compared to the blood vessels may be densely adherent to the wall of the sac, and a little cutting may be necessary to free it. The sac should be entirely freed until it is attached only at the internal ring, the gauze sponge is removed from the sac and while forceps are used if necessary to keep the viscera in the abdomen, a transfixion ligature is placed in the neck of the sac as high up as possible. This is tied (Figure 67), the sac is cut off about 1 cm. distal to the ligature, one end of the ligature is cut off and the other is threaded on a needle. The needle is inserted under the internal oblique and transversus muscles and made to emerge about 2 cm. from the muscle margin. When tension is made on this, the neck of the sac is pulled up behind the muscle, another bite with the needle is taken in the muscle and the suture is tied. When the hernia is of the congenital' type and a long vaginal process is present extending down to or in the neighborhood of the testis, it may be practically impossible to separate part of this structure from other structures of the cord, and it may be necessary to leave a strip of the vaginal process attached to the cord. In some of these cases, when the sac is opened the cord appears to lie in the sac and bears the same relation to the sac as the testis does to the tunica vaginalis. When the process extends down to the testicle that portion around the testicle may be treated the same as in a hydrocele operation (page 587). The testicle is brought up into the wound, the vaginal process is partially excised, and the remainder inverted around the testicle. Some authorities believe that no harm is done by leaving the distal part of the sac in place. When an encysted hydrocele of the cord is found, the hydrocele sac is opened and excised as well as possible.

With the cord pulled up or down out of the way, the first layer of suturing to repair the hernia is begun by passing a needle carrying #1 chromic catgut through the most medial portion of the conjoined tendon and thence to the shelving margin of the inguinal ligament where it attaches to the pubic bone. When this suture is tied, the tendon is brought into approximation with the ligament, and the internal-oblique and transversus muscles come down to a similar position. The suture is continued laterally to the internal abdominal ring (Figure 68), where it is tied, care being used not to strangulate the cord. If preferred, interrupted sutures of silk may be used throughout instead of catgut. The tape is removed from the cord and it is laid in its new bed on top of the internal-oblique muscle and conjoined tendon. Using a similar continuous chromic catgut suture, the external-oblique aponeurosis is closed (Figure 69), using care in this case not to strangulate the cord where it emerges from the external abdominal ring. There should be enough space in the ring after it has been properly sutured to admit the tip of the little finger alongside the cord. If desired, the aponeurosis may be overlapped to give additional strength. After perfect hemostasis is assured, the superficial

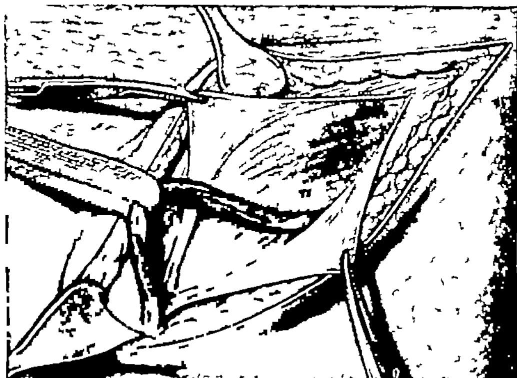


Fig. 68. *Indirect Inguinal Hernia.* The internal oblique and transversus muscles and conjoined tendon have been sutured to the inguinal ligament underneath the cord.

Fig. 69 *Indirect Inguinal Hernia.* The external-oblique aponeurosis has been closed and suturing of the skin has been started.

fascia may be closed with a continuous suture of plain #000 catgut and the skin closed with dermal The operation just described is the one most commonly used and is the method attributed to Bassini

Ferguson Method In this method of repair the cord is not transplanted on top of the internal-oblique muscle but is pushed back against the transversalis fascia, and the internal-oblique and transversus muscles and conjoined tendon are sutured to the shelving margin of the inguinal ligament in front of it. Care should be used not to constrict the cord where it emerges between the conjoined tendon and the inguinal ligament, and through the external abdominal ring

Halsted Method The procedure here is the same as the Bassini method, except that the cord is transplanted not only on top of the internal-oblique muscle but also on top of the aponeurosis of the external oblique. While the cord is held aside, the conjoined tendon is sutured to the inguinal ligament as was described in the Bassini operation, and then the external-oblique aponeurosis is also closed under the cord with care not to constrict the cord where it emerges through the external-oblique aponeurosis opposite the internal abdominal ring. At the conclusion of this operation, the cord lies between the external-oblique aponeurosis and the superficial fascia. This is the operation usually performed by the author

Rectus Fascia Transplant When the abdominal wall including the fascia is weak, the floor or roof of the inguinal canal may be reinforced with a portion of the rectus sheath. The upper skin margin of the incision is retracted medialward, cleaning off the external-oblique aponeurosis *en route* until the edge of the anterior rectus sheath is in view A flap of the anterior rectus sheath is cut off medially so it can be turned laterally like a trapdoor and brought down to the inguinal region. This flap is sutured to the external-oblique aponeurosis after the latter is closed.

Fascial Suture When there is poor muscle and fascia, or when the hernia is a recurrent one, the use of fascia taken from the thigh is of value in preventing recurrences The fascia is obtained from the fascia lata on the lateral surface of the thigh, either using a Masson fascia stripper or by making an incision some 15 cm long on the lateral aspect of the thigh and cutting out a piece of fascia about 4 cm. wide and the length of the incision. This fascia is cut in strips about 1 cm. wide and interlaced across the suture line, a special heavy needle being used for the purpose. Such a fascial suture is most valuable when used to reinforce the junction between the internal-oblique muscle and the inguinal ligament.

Fascia may also be obtained by cutting a strip from the external oblique aponeurosis starting on the lateral end and leaving the strip attached at its medial end. The loose end of the fascia is threaded on a needle and used to reinforce the catgut sutures.

Non-Absorbable Sutures Silk, cotton, tantalum, or stainless steel can

be used to advantage, particularly in the repair of a recurrent hernia. These sutures should be interrupted and the ends should be cut off close above the knot, to avoid excess foreign matter in the wound.

Sliding Hernia The portion of bowel usually involved in a sliding hernia is the cecum on the right and the sigmoid colon on the left, the posterior wall of the bowel making up a portion of the hernial sac. Since the uncovered surface is usually on the posterior wall of the sac, the latter should be opened routinely from the front. If large bowel is found to be adherent to the sac, sliding hernia should be suspected. If the bowel should be accidentally opened, it should be closed with two layers of chromic catgut sutures and, if there has been any soiling, the wound should be thoroughly irrigated with normal saline solution. The wound should not be drained but, if infection should develop a rubber tissue drain can be inserted later The sac should be opened as widely as possible and cut off a short distance from where it is adherent to the bowel. By gauze stripping, the bowel and its blood supply are freed and lifted up so that the raw surface can be peritonealized and the bowel mobilized sufficiently to return it to the abdomen. While the bowel is held in the abdominal cavity a pursestring suture is placed around the abdominal ring and tightened so as to exclude the bowel from the hernia. The abdominal wall is then dealt with by the Bassini method or by one of the other methods described above

Recurrent Hernia It is in these cases that fascial suturing is of value, if the muscle and fascia are thin. The dissection of the sac is often difficult because of scar tissue and altered anatomic relations. In an elderly patient, orchidectomy with ligation and removal of the spermatic cord at the internal abdominal ring is helpful in strengthening the abdominal wall.

Combined Direct and Indirect Inguinal Hernia If a direct hernia is present in addition to the indirect hernia, the sac of the indirect hernia should be dealt with and then the sac of the direct hernia should be treated as described under direct hernia. When a direct hernia is present, I prefer to do the Halsted operation, since it gives reinforcement in the region of the external ring

If it should be found at operation that the hernia that was thought to be inguinal is actually femoral, the cord should be lifted up the transversalis fascia in the bed of the cord incised, and the femoral canal closed above the inguinal ligament.

Inguinal Hernia in the Female Operation for inguinal hernia in women is simplified by the absence of the cord. The sac should be identified, ligated as high as possible and the external oblique and transversus muscles should be brought down to the inguinal ligament. The round ligament may be more or less ignored but if it is cut the ends should be tied since there may be a small vessel in it.

Inguinal Hernia in Babies Here the structures are very thin, but after high ligation of the sac the results are good from any method of repair

Irreducible Hernia Inability to reduce a hernia may be due to adhesions between the wall of the sac and the contained structures This is often seen when the patient has been wearing a truss It may also be due to a relatively small internal ring In the former case painstaking dissection is necessary to free the bowel from the sac, but if necessary a portion of the sac may be left attached to the bowel, its edges trimmed as closely as possible, and the bowel and sac tissue returned to the abdomen. When there are extensive adhesions between the omentum and the sac wall it is sometimes easier to clamp and tie off a portion of the omentum and sacrifice it along with the sac. If the irreducibility is due to a small ring the sac is opened high up and the opening is enlarged by cutting the neighboring muscle as much as necessary

Strangulated Hernia If strangulation is present, as soon as the hernial sac is opened fluid under pressure will pour out This fluid in the early period of strangulation is clear but as time goes on red blood cells enter the transudate and give it a pink and later a bloody appearance. If there is gangrene of the intestine, the fluid may have a foul odor The first procedure in strangulated hernia after the sac is opened is relief of the strangulation. This must be done usually by enlarging the internal abdominal ring by cutting the internal oblique and transversus muscles in a direction away from the inguinal ligament as far as necessary With release of the constriction, the strangulated viscus should be studied in regard to its viability If the strangulated structure is omentum the portion in question may be clamped, tied off and removed without more ado if bowel is involved the surgeon is often confronted by a very difficult problem. Strangulated intestine, which varies in color from dark red to crimson and purple, should show signs of returning to normal color within a short time after strangulation is removed. Hot packs applied to the bowel help in restoring the circulation. If after five minutes the bowel has still not improved in appearance, it must be considered non viable. If on the other hand, pulsation is apparent in the mesenteric vessels and the bowel is becoming pinkish and has its normal tone it may safely be returned to the abdomen. In those cases where the bowel is almost black, covered with exudate, and surrounded by foul smelling fluid, no time need be wasted in attempting to restore the circulation, since it is obvious that the bowel is dead. In other cases the bowel may be dark in color with less than normal luster but not thin walled, as it often is when gangrene has set in and the release of the strangulation appears to improve the color of the bowel a little. Fluid found in the sac may be pinkish but not definitely bloody In other words, here the surgeon is confronted with definite evidence of increased permeability of the bowel wall as shown by the presence of red-blood cells in the

fluid, and although the intestine appears to have taken on some color the general picture indicates that the loop cannot safely be placed in the abdomen. Between the condition just described and that seen when the circulation of the bowel is unquestionably restored, there are many cases that tax the judgment of the surgeon. In some of these doubtful cases, in very rare instances the repair of the hernia should be ignored and the questionable loop left on the abdominal wall surrounded by moist packs. If the circulation returns, the bowel can be returned to the abdominal cavity and the hernia repaired in a day or two depending on the condition of the patient. If gangrene develops a de Pezzar catheter or flanged glass tube may be tied in the exposed good bowel above the gangrenous area and the necrotic segment clamped off and removed. A clamp is left on the distal segment of good bowel for seventy two hours or longer If the patient recovers, a secondary operation is done to anastomose the two segments together and repair the hernia.

Returning now to the case in which the bowel found in the hernial sac appears to be non viable, if the patient s general condition is good, resection of the involved segment and end to-end or lateral anastomosis may be done followed by repair of the hernia. In other circumstances, it is good judgment to excise the gangrenous segment, tie a catheter or glass tube into the proximal loop of good bowel, clamp off the distal segment, and bring the two ends out on the abdomen through the hernia incision. The tissues of the abdominal wall are loosely closed, but no attempt is made at anatomical repair of the hernia.

Direct Inguinal Hernia In the repair of a direct inguinal hernia, the inguinal canal is exposed by the same method used in indirect inguinal hernia (Figure 70) The cord is lifted from its bed and the sac of the direct hernia is seen in Hesselbach s triangle, which is made by the inguinal ligament, the deep epigastric vessels, and the lateral margin of the rectus muscle. A tape is passed under the cord and it is not necessary to incise the cremasteric and infundibuliform fascia of the cord unless one suspects the presence of an indirect hernia. In direct hernia, in many cases there is a simple wide bulge in Hesselbach s triangle and it is merely necessary to push back and plicate the transversalis fascia with a few sutures (Figure 71) If there is a large sac, it should be opened by cutting through the transversalis fascia and peritoneum, replacing the contents in the abdominal cavity closing the neck of the sac by a purse-string suture, and suturing the transversalis fascia. In some cases, combined with a hernia in Hesselbach s triangle, there is another hernia lateral to the deep epigastric vessels. This hernia is not in the substance of the cord and is an indirect hernia only by definition, since it is lateral to the deep epigastric vessels. A so-called pantaloon sac of this type should be converted to one sac by drawing the lower sac through underneath the deep epigastric vessels, after which the sac can be

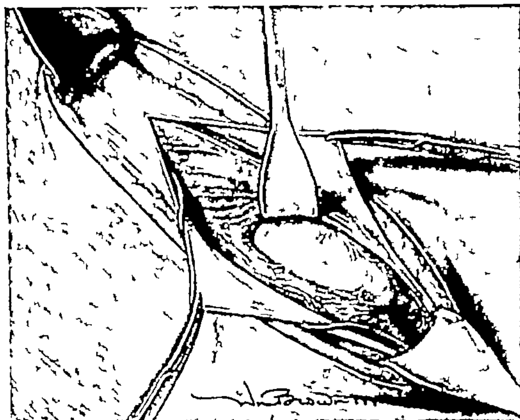


Fig. 70. *Direct Inguinal Hernia* The skin and external-oblique aponeurosis have been incised. The internal oblique and transversus muscles are being lifted up by a retractor and the hernial sac is apparent above the cord.

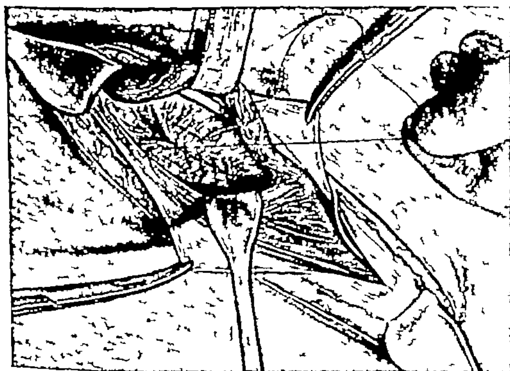


Fig. 71. *Direct Inguinal Hernia.* The sac has been inverted into the abdomen and the transversalis fascia is being sutured.

opened and its neck sutured, or it can be plicated after being reduced. In direct hernia, because of the weakness in Hesselbach's triangle the cord should be transplanted by the Bassini or Halsted technique (Figure 72) additional reinforcement may be obtained by turning over a



Fig 72. *Direct Inguinal Hernia* The internal oblique and transversus muscles have formed the conjoined tendon which is being approximated to the shelving margin of the inguinal ligament.

flap of the rectus sheath, by the use of fascial sutures, or by overlapping the external-oblique aponeurosis.

Femoral Hernia In general the best approach to a femoral hernia is by an incision exactly the same as that used for inguinal hernia. The skin and subcutaneous tissues are incised, and the aponeurosis of the external oblique is divided in the direction of its fibers down to the external ring The lower flap of the external-oblique aponeurosis is caught with hemostats and dissected free down to the inguinal ligament. The cord is lifted from its bed and a tape passed around it so that it can be held up out of the way A retractor is inserted and the conjoined tendon is pulled upward. The transversalis fascia in Hesselbach's triangle is incised (Figure 73) and if possible the sac is pulled upward from underneath the inguinal ligament (Figure 74) If this can be accomplished it is not necessary to open the peritoneal cavity until an incision is made in

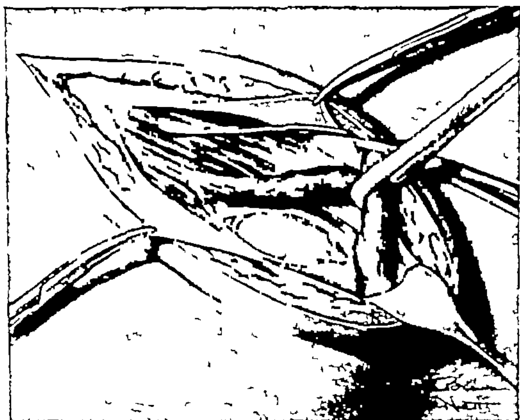


FIG. 73. *Femoral Hernia (Abdominal Approach)* The external-oblique aponeurosis has been incised and an incision has been made through the transversalis fascia under the cord. The sac is visible.

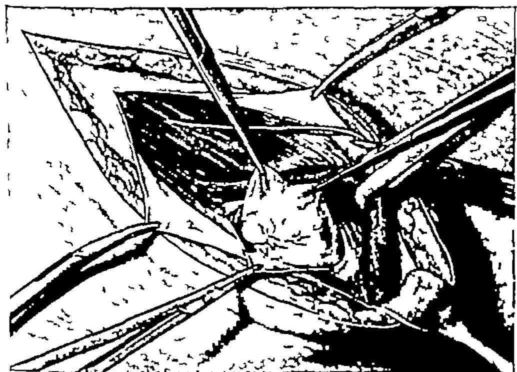


FIG. 74. *Femoral Hernia (Abdominal Approach)* The sac has been pulled up from the femoral canal and is about to be opened.

the delivered sac to reduce the contents If the sac cannot be deliv the peritoneum, which lies underneath the transversalis fascia, sh be incised and the fingers inserted into the peritoneal cavity to pull any viscera that are herniated into the sac. By combined pressur the upper part of the thigh and pull on the bowel or omentum, the usually no difficulty in delivering these structures from the herni the bowel is strangulated, however delivery cannot be accompli without enlarging the neck of the sac. An incision should be n



FIG. 75 *Femoral Hernia (Abdominal Approach)* The neck of the sac has be ligated and the sac removed. Inguinal ligament and transversalis fascia sup ficially are being connected by sutures to more deeply placed layers. These the lateral extremity of Cooper's ligament and the interfoveolar ligament.

medially to cut the lacunar ligament. If the ring is still not large enou the inguinal ligament must be cut but this should be avoided if p sible. If the ligament is cut diagonally it can be sutured more easily the conclusion of the operation. The bowel or omentum having been moved from the sac, it is dealt with as described under inguinal her The sac is pulled up and out, a transfixing suture is inserted, the nec tied off and the sac is removed. The femoral ring is closed by placin few sutures of #1 chromic catgut or fine silk between the inguinal li ment and Cooper's ligament (Figure 75) the latter being a band t extends laterally along the pectineal line from the base of the lacu ligament If the needle is passed inward until it barely misses the s face of the bone it will take a bite in Cooper's ligament. The opening the transversalis fascia is closed with a running suture of catgut or terrupted sutures of silk, the cord is replaced in its bed, and the extern

oblique aponeurosis and skin are closed as in inguinal hernia. In all manipulations the femoral vein which lies just lateral to the femoral canal, should be carefully protected

Femoral hernia may also be repaired by a vertical or horizontal incision below the inguinal ligament in the region of the fossa ovalis The incision is deepened down to the fascia lata and the sac will be seen bulging from the femoral canal The sac is opened (Figure 76A) the contents are pushed back into the abdominal cavity a pursestring suture

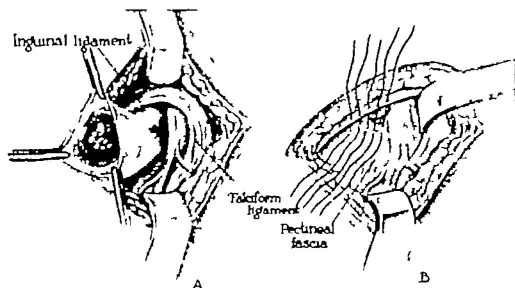


FIG. 76. *Subinguinal Approach to Femoral Hernia.* A. The sac has been isolated and opened and is seen to contain omentum. B The sac has been ligated as high as possible and cut off The pectineal fascia is being sutured to the inguinal ligament.

is inserted as high up as possible, and the sac is cut off. The femoral vein, which lies just lateral to the sac, should be carefully avoided. After the sac has been ligated, a few interrupted sutures are placed between the inguinal ligament and the pectineal fascia to close the canal (Figure 76B) If the contents of the hernia cannot be reduced, it is necessary to cut the lacunar ligament and sometimes the inguinal ligament If strangulated bowel is found, an abdominal incision must be made to enter the peritoneal cavity or if a vertical incision has been used, it can be extended upward for this purpose. The infra inguinal approach is less satisfactory than the supra inguinal when it comes to closure of the inguinal canal, but it is a more direct approach to the sac itself

Umbilical Hernia Herniation through the umbilical ring is often seen in babies and usually disappears spontaneously when the child is about three years old. If the hernia is large and shows no signs of improvement after having been held in reduction by a truss or adhesive plaster dressing, operation must be done but it should be postponed if

possible until after the child is two years old. Umbilical hernia in adults, a common condition, may represent herniation through the umbilical ring or through the linea alba in the immediate neighborhood of the ring In the latter case, swelling soon causes a protrusion of the umbilicus. When associated with diastasis of the rectus muscles, umbilical



FIG. 77 *Umbilical Hernia.* The umbilical region has been freed by an elliptical incision. The peritoneum is seen extending upward into the hernial sac.

hernia may become very large and contain a great deal of omentum and small intestine Intrasacular adhesions may cause loculation and irreducibility and strangulation often occurs

In repairing an umbilical hernia in a child, it is desirable for cosmetic reasons to save the umbilical dimple· in most cases this can be done satisfactorily In the adult, particularly when the hernia is large, an elliptical incision should be made around the umbilicus which should then be excised (Figure 77) Regardless of the method used, the skin and sub-

cutaneous tissues should be carefully dissected off the hernial sac; if necessary when the sac is approached, an incision may be made into it so that a finger can be introduced and hooked outward to make certain that the skin dissection does not injure any of the sac contents The sac is opened and its contents are reduced to the abdomen, the ring being

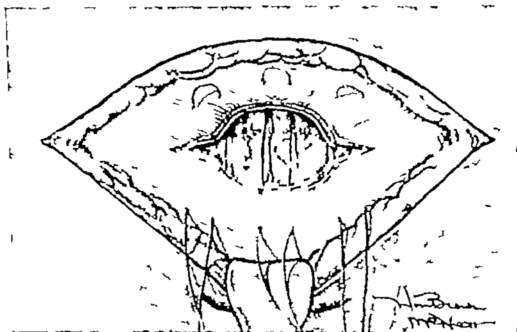


FIG. 78. *Umbilical Hernia.* The abdominal wall, consisting of peritoneum, thinned-out muscle, and fascia, is being overlapped by mattress sutures.

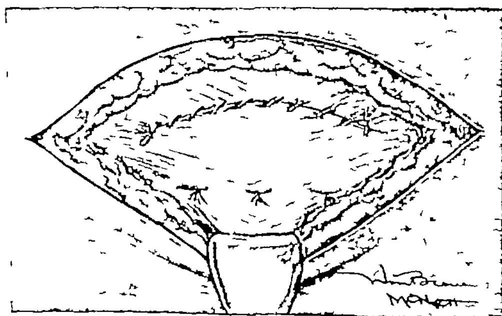


FIG. 79. *Umbilical Hernia.* The mattress sutures have been tied and another continuous layer of sutures has been inserted.

enlarged by cutting it laterally if necessary If strangulated omentum is present, it may be clamped tied off and removed. If gangrenous bowel is present the same principles apply here as were discussed under inguinal hernia. In a small hernia, after the sac has been removed the rectus muscles and peritoneum may be brought together in the midline by continuous sutures of catgut or interrupted sutures of silk. In a large hernia, after the sac is isolated, opened, and removed the skin and subcutaneous tissues should be dissected widely off the anterior rectus sheath and the ring closed by pulling the upper portion of the abdominal wall down over the lower and anchoring it in this position by two rows of mattress sutures (Figures 78 and 79) All of the first layer of sutures are inserted before any is tied. The subcutaneous tissues are brought together by a continuous suture of plain catgut, and the skin is closed with dermal.

Incisional and Ventral Hernia When a scar is present in the skin, it should be dissected out by an elliptical incision. The hernial sac is dissected out, the contents are returned to the abdomen, and the sac is freed up to its neck. If the opening in the neck of the sac is wide and the abdominal muscles are thin, an overlapping closure of the entire thickness of the abdominal wall and peritoneum, such as that described under umbilical hernia (Mayo method) may be used, but the overlapping is done from side to side. If the abdominal wall is thick or if there is not sufficient slack, a layer closure should be done. First the neck of the sac is closed and then a few sutures are inserted to bring the muscles together The fascia is closed by continuous or interrupted sutures and may be overlapped if desired. The skin is closed with dermal.

Obturator Sciatic and Perineal Hernia In these conditions the simplest method of treatment is usually laparotomy with reduction of the hernial contents, closure of the ring as well as possible, and suture of the neck of the sac after it has been invaginated and removed.

Lumbar Hernia An incision over the bulging mass in Petit s triangle is carried down to the hernial sac. The sac is opened, the contents are reduced to the abdomen, the neck of the sac is closed, and the sac is removed The muscles are brought together as well as possible by interrupted sutures, following which the skin is closed with dermal

Abdominal Incisions

Rectus Incision This incision is parallel to and passes through the fibers of the rectus muscle It is the most commonly used of all incisions. The length of the incision should ordinarily be about the width of the surgeon s hand. It may be made in any quadrant of the abdominal wall If desired, the middle of the incision may be located at the level of the umbilicus, and after exploration may be extended upward or downward as is indicated by the findings. The skin and subcutaneous tissues are

incised and, after bleeding vessels have been caught and tied, towels are applied to the wound edges and the incision is continued through the anterior rectus sheath. The handle of the knife is used to separate the muscle in the direction of its fibers throughout the length of the inci

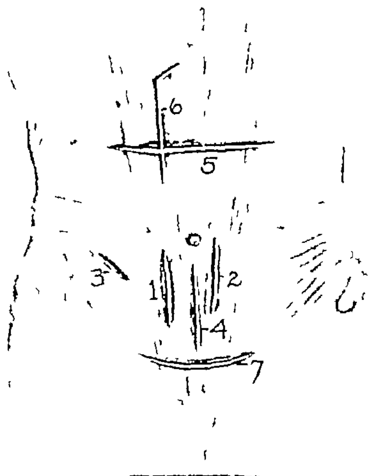


FIG. 80 *Abdominal Skin Incisions* 1 Right rectus incision 2. Left paramedian incision. 3. McBurney incision 4. Lower midline incision 5 Transverse incision 6. Hockey-stick incision 7 Pfannenstiel incision.

sion, and the wound is pulled open by retractors. Bleeding vessels in the muscle edges are caught and tied, and if a vessel is seen crossing the line of the incision deep to the muscle two hemostats are applied to it and it is cut between them and tied. The surgeon picks up the peritoneum by grasping it delicately with thumb forceps, and about 1 cm. away from this the assistant takes a similar bite with a hemostat. The surgeon releases his hold and takes another bite and the assistant does the same this is a precaution against the bowels being caught with the peri

toneum. As the peritoneum is now held up it is very carefully incised. When there is abdominal distention or if the patient is straining, the intestinal wall may be plastered tightly against the peritoneum and may be cut unless the utmost care is exercised. If this accident should happen, the peritoneum should be widely opened at once, the bowel quickly grasped, pulled out into the wound, packed off and the opening sutured. If the wound is small, leakage may be prevented by grasping the bowel in the region with an Allis forceps, but in any case clamping the loop in the fingers will serve effectively After the peritoneum has been opened, the assistant releases his grasp of it and the surgeon inserts the first two fingers of his left hand and cuts it between the fingers as he lifts it up. The incision in the peritoneum is continued to the right the full length of the wound. The surgeon then inserts the index finger in the left portion of the peritoneal opening, the assistant inserts his left index finger and the peritoneum is cut to the left as the two fingers lift it up

Closure of the incision is begun, after hemostasis is assured, by applying a hemostat to the peritoneum at each end of the wound and another on each side at about the middle. The hemostat on the right end of the peritoneal opening is lifted up by the surgeon while he inserts the first stitch as he ties it the hemostat is removed. The short end of the catgut is cut off and the assistant grasps the long end in his left hand to make tension on it. The surgeon lifts up the hemostat attached to the midpoint of peritoneum on his side the assistant lifts up the opposing hemostat on the other side in the right hand, and the running suture is put in The needle should always penetrate the inner surface of the peritoneum and come out on the inner surface, so that when the suture is tightened the peritoneal edges will be everted. If prolapsing bowel interferes with the closure it is held out of the way with a laparotomy pad. When the suture line reaches the points where the two hemostats are attached they are removed, and the assistant grasps the remaining hemostat and holds it up as the surgeon picks up the peritoneum as necessary with thumb forceps held in his left hand. The suture line is completed and tied as the last hemostat is removed. The anterior rectus sheath is brought together by a running suture of chromic catgut on a curved needle, beginning at the surgeon's right hand and ending at the left. The assistant, using a gauze sponge, pulls back the subcutaneous tissue on his side of the wound to provide exposure. The subcutaneous tissue should not be dissected off the anterior rectus sheath unless this maneuver is necessary in order to overlap the rectus sheath. Unnecessary undermining of the wound provides space for serum to collect and serves no useful purpose. Three or four tension sutures, or one for about every 3 cm. of the wound, are inserted. These are sutures of silkworm gut or nylon threaded on a large curved cutting needle The needle penetrates the skin about 2 cm. from the edge of the incision,

passes inward through the sutured anterior rectus sheath, and over and out through the skin on the opposite side at about the same distance from the edge. A hemostat is applied to each end of these sutures and they are not tied until the dermal closure is completed. The skin is closed with a continuous suture of dermal.

Paramedian Incision This incision is made about 2 cm lateral to the medial edge of the rectus muscle. The anterior rectus sheath is incised and the muscle, after being dissected loose at the semilunar lines is pulled laterally by retractors so that the posterior rectus sheath and peritoneum can be cut without splitting the muscle.

McBurney Incision The midpoint of the incision is located about one-third of the distance between the anterior superior spine and the umbilicus, and the skin and external-oblique aponeurosis are incised in the direction of the fibers of the latter Retractors are inserted to pull the margins of the aponeurosis aside after a superficial cut with the knife, the handle of the knife is inserted and the fibers of the internal-oblique and transversus muscles, running almost horizontally across the abdomen, are split. The retractors are removed from the external-oblique aponeurosis and reinserted into the opening in the muscle The peritoneum is opened as described above. In closing the incision, the peritoneum is closed with a suture of plain catgut, and chromic catgut is used for the aponeurosis of the external oblique. The subcutaneous tissues may be closed with a continuous suture of catgut, in small incisions simple closure of the skin with dermal is sufficient.

Midline Incision This incision may be used above or below the umbilicus, and if necessary a midline incision above the umbilicus may be joined with one below by making an arch around the umbilicus preferably on the left side. If the incision is made exactly in the midline no muscle is encountered. The skin and fascia of the linea alba are incised and the peritoneum is picked up and opened. If the exact midpoint was not attained, the muscles may be separated to one side or the other so that the peritoneum may be opened between them. In closing the incision, a continuous suture of plain catgut is used for the peritoneum, another of chromic catgut for the fascia, and the skin and subcutaneous tissues are closed as usual. A subcutaneous suture is not necessary but I prefer to use it when no tension sutures are used. Tension sutures may be used for a midline incision if desired.

Hockey-Stick Incision This incision, which may sometimes be used to advantage in cholecystectomy consists of a rectus incision, the upper end of which is prolonged at an obtuse angle to the region of the xyphoid process, the rectus muscle being cut for a short distance.

Pfannenstiel Incision This incision has the advantage of leaving an inconspicuous scar but it does not lend itself well to extension upward and the undermined flaps predispose to the accumulation of serum and

infection of the wound. It is a curved incision with the convexity downward and about 3 cm. above the pubic bone. The incision passes through the skin, superficial fascia, and the anterior rectus sheath on each side. This sheath is grasped by hemostats and dissected upward off the muscle, the linea alba being cut to release it in the midline The peritoneum is opened in the midline and the usual retractors are inserted. In closing the incision the peritoneum is sutured with plain catgut, the anterior rectus sheath is dropped back in place and sutured with chromic catgut, and the subcutaneous tissues and skin are closed as usual.

Transverse Incisions· Vertical incisions are most commonly used because they extend in the direction of the fibers of the rectus muscle and parallel to the blood supply and they can be easily and quickly enlarged upward or downward as the occasion demands The latter advantage is an important one, so much so that the vertical incision is most certainly indicated when the exact location of the lesion is in doubt. Transverse incisions on the other hand, are coming now into more general use, and since they split the rectus sheath in the direction of its strongest fibers and protect the nerve supply of the muscle they are believed to give a stronger abdominal wall postoperatively In many operations also the transverse incision undoubtedly provides better exposure. Since a long transverse incision can be made only below the lower borders of the ribs and above the crests of the iliac bones and should not extend through the umbilicus most incisions are made either about 2 cm above or 2 cm. below that structure, although for shorter incisions any level may be used. An incision may extend, when above the umbilicus from the tip of the twelfth rib on one side straight across to the tip of the twelfth rib on the other side. If such a long incision is not necessary it may be made only between the tip of the rib and the midline or a short distance past the midline. For operations on the gallbladder common duct, stomach, and hepatic flexure of the colon, such an incision is made on the right side for operations on the splenic flexure of the colon or the spleen, the incision is made on the left side above the umbilicus. A left sided incision below the umbilicus may be indicated for resection of the descending colon, and on the right side for operations on the terminal ileum or appendix. The infra-umbilical incision may extend entirely across the abdomen for pelvic operations In any case, whenever necessary a vertical incision in the midline may be added to the transverse incision for additional exposure.

Two types of transverse incision are commonly used, one that divides the rectus muscle and one that provides for its retraction When the muscles on both sides are to be divided, a supra-umbilical incision begins near the tip of the twelfth rib and is extended across to the tip of the twelfth rib on the other side. The skin and subcutaneous fascia are cut and the anterior rectus sheath is divided. While the muscle fibers

are being cut, large vessels are watched for and clamped. The posterior rectus sheath, transversalis fascia, and peritoneum are incised and with the aid of two fingers lifting up the peritoneum the incision is extended laterally to the ribs, the external oblique and transversus being split in the direction of their fibers and the internal oblique cut across. The falciform ligament is clamped and ligated. When a unilateral incision is sufficient the procedure is the same, but only one rectus muscle is cut and the incision extends from the rib to or slightly past the midline.

Before closure of the incision is begun, the head and foot of the table are raised slightly to aid in bringing the abdominal wall together Suture of the peritoneum is started on one end of the incision and the cut ends of the falciform ligament and posterior rectus sheath are included. No sutures are placed in the rectus muscle, the next layer of sutures including the anterior rectus sheath, the external-oblique aponeurosis or the internal-oblique and transversus muscles. The skin is closed as usual.

When a transverse incision with retraction of the muscle is desired, the skin and subcutaneous tissues are cut down to the anterior rectus sheath. The sheath is incised transversely and separated from the muscle 1 or 2 cm. above and below the incision. The muscle is freed from the anterior sheath by sharp dissection, since it is not attached to the posterior sheath, it can then be pulled medially or laterally The ninth intercostal nerve, which will be visible in the incision, is retracted along with the muscle. The muscle is held aside by a retractor while the posterior sheath and peritoneum are incised and the incision continued as usual In the case of a unilateral incision, the rectus is retracted toward the midline for a bilateral incision both muscles are retracted laterally In those cases in which it is desired to cut the muscle on one side and retract it on the other the mu.cle is cut on the side where best exposure is desired, and the muscle on the other side after being freed, is pulled laterally Closure of these incisions is accomplished by the method already described.

POSTOPERATIVE CARE

If a transverse incision has been used it is well to have the bed slightly dropped in the center to relieve tension on the abdominal wound. If an operation for hernia has been performed, the incision should be supported by liberal adhesive strappings or by an abdominal binder In the case of an inguinal hernia, particularly if it has been necessary to remove the testicle from the scrotum, an adhesive-plaster bridge across the thighs should be provided to support the scrotum. Liberal sedation should be supplied to prevent coughing straining at stool is avoided by enemas or laxatives at the appropriate time. Abdominal distention should be prevented as much as possible by the use of enemas, pitressin, and gastric suction or intestinal intubation, as indicated.

CHAPTER XI

The Peritoneum, Retroperitoneal Tissue, and Adrenal Gland

The Peritoneum, Retroperitoneal Tissue, and Adrenal Gland

The delicate membrane of peritoneum, which lines the abdominal cavity and covers the viscera, is capable of setting up a powerful defense mechanism against the growth and spread of infective organisms. Reinforced by the localizing and absorptive power of the omentum, it is able to limit the spread of all but the most overwhelming infections and wall off many sites of injury The ability of the peritoneum to produce a rapid cellular serous and fibrinous response, and of the omentum to surround a diseased region and the action of both omentum and peritoneum in absorbing blood and pus when the inflammation has been conquered, make these structures deserving of the greatest respect on the part of the surgeon.

PREOPERATIVE TREATMENT

Lost fluid, protein, and chloride should be restored. Morphine should be given as necessary for pain as soon as the diagnosis has been made. Abdominal distention and vomiting are treated by the use of an indwelling suction tube in either the stomach or the small bowel. When operation on a patient with peritonitis is to be deferred, penicillin should be administered every three hours in doses up to *200 000 units In some* cases streptomycin is of value although this antibiotic is most effective against infection by gram negative bacilli. Sulfonamides may be used instead of or in conjunction with penicillin, but are not as reliable in most cases

LESIONS OF THE PERITONEUM RETROPERITONEAL TISSUE AND ADRENAL GLAND

Peritonitis

Inflammation of the peritoneum may be acute or chronic, localized or generalized septic or aseptic, and primary or secondary

Acute Peritonitis This condition is usually septic and usually secondary being due to the spread of infective organisms from a primary lesion in some other intra abdominal organ A few hours after bacteria become free in the abdominal cavity there is a dilatation of the peritoneal blood vessels, and soon polymorphonuclear leucocytes begin to pass through the vessel walls to destroy the bacteria by phagocytosis Peritoneal fluid, which normally is present only in an amount sufficient to lubricate the intra-abdominal organs, increases rapidly and exercises its protective action. If the bacteria continue to multiply flecks of fibrin appear in the clear fluid and fibrinous exudate covers the more acutely inflamed portions of the peritoneum. The polymorphonuclear leucocytes increase in number the serofibrinous fluid gradually changes to pus, the coils of bowel tend to be glued together by fibrin and the free edge of the omentum, which has made its way to the most inflamed area, attempts to surround and seal off the septic focus. The peritoneal covering of the bowel, which at first appears reddened and covered with flakes of fibrin, after pus has been present for some time becomes dull and lusterless

The peritonitis may be confined to the immediate neighborhood of the source of infection if the leakage of bacteria into the peritoneal cavity is slow, the pathogenicity of the organism low or the defense mechanism well developed. Cohesion of adjacent loops of bowel caused by fibrin, efficient enveloping action of the omentum, and effective cellular and serous response and removal of the focus all aid in keeping the inflammatory process from spreading If on the other hand, the infection is overwhelming or the resistance of the patient poor or the cause of the peritonitis is a quickly diffused, irritating and infective fluid such as one sees in perforated ulcer generalized inflammation of the peritoneum soon takes place. 'Generalized, as applied to peritonitis is a relative term, since actual involvement of every part of the peritoneum practically never occurs but it is a useful clinical classification. When the peritonitis is not localized but is not yet generalized, it is said to be spreading or diffusing, and this also is an important clinical distinction. Increased fluid is often present in the peritoneal cavity when only a localized infection is present, and unless this fluid contains fibrin it may be considered as a response to irritation. On the other hand, if when the peritoneal cavity is opened, serofibrinous or purulent fluid comes out under pressure from among free-lying coils of bowel, one should assume that generalized peritonitis is present. No attempt should be made to explore the abdominal cavity in order to determine the extent of the infection.

The most common type of septic peritonitis is that resulting from infection by Escherichia coli, an organism whose normal habitat is the gastro-intestinal canal Due to perforation, inflammation, or gangrene of some part of the gastro-intestinal tract most commonly the appendix, but often the gallbladder or the small or large intestine the bacteria

enter the peritoneal cavity and with the development of pus the characteristic fecal odor produced by this organism is apparent. Very commonly the peritonitis produced by the colon bacillus is a mixed infection, and other organisms particularly the streptococcus the staphylococcus, the anaerobic group or others of the enteric group are found. The farther down in the intestinal tract the infection originates, the more numerous are the bacteria, but this does not necessarily mean that a perforation in the sigmoid colon is more likely to cause generalized peritonitis than a perforation in the duodenum, since the ability of the body to wall off a source of infection must be taken into consideration. In general, however inflammatory lesions of the colon are much more serious than those of the higher gastro-intestinal tract, and it is only because bacteria from a perforated ulcer are quickly spread throughout the abdominal cavity in an irritating medium that this particular lesion is so dangerous.

When the streptococcus pyogenes is the etiologic factor the infection tends to be of a fulminating type. Fortunately this is not often seen in infections of gastro-intestinal origin, but it is the usual type in puerperal sepsis. The peritoneal exudate is thinner and contains little or no fibrin since the coils of bowel do not tend to become adherent, the infection spreads rapidly

Gonococcal peritonitis, nearly always seen in the female, originates from an infection in the Fallopian tubes. This type of peritonitis has a strong tendency to remain localized in the pelvis many adhesions are formed, and the acute manifestations tend to subside spontaneously

Pneumococcal peritonitis, usually a disease of children, is of two types, primary and secondary Primary pneumococcal peritonitis is nearly always encountered in girls and is probably due to an infection of the peritoneal cavity by bacteria that find their way in through the Fallopian tubes It begins as a pelvic peritonitis but later becomes generalized. The secondary type follows a pneumococcal infection elsewhere in the body usually in the lungs, and the organisms reach the peritoneal cavity through the blood stream or lymphatics This is a common complication of nephrosis The exudate in pneumococcal peritonitis is thick and stringy and the pus often has a greenish color

Primary peritonitis is often produced by trauma to the peritoneum, most commonly by rough handling of the bowel in an operation. Gauze rubbed carelessly across the peritoneal covering produces an injury that is soon followed by a response like that caused by infection.

A common type of secondary peritonitis is the aseptic peritonitis produced by the entrance of bile, blood or urine into the abdominal cavity The peritoneal response is similar to that seen in septic peritonitis, but the first two of these irritants are not active enough to cause rapid inflammatory response Hydrochloric acid from the stomach, on the other

hand, may cause severe and early peritonitis. Any peritonitis that is aseptic in the beginning usually becomes complicated eventually by bacterial infection

The end result of acute and progressive generalized peritonitis is paralysis of the bowel caused by the action of bacterial toxins The bowel becomes distended and thinned out and, with interference in the blood supply actual perforation or rupture may take place, but the results of intestinal obstruction early become manifest and death usually supervenes. In other cases the inflammatory process is overcome throughout most of the peritoneal cavity but a residual area of infection remains and becomes walled off as an abscess. In the more fortunate patient, complete resolution of the inflammatory process takes place, and if the peritoneal cavity is opened a few weeks later there may be no evidence of a previous inflammatory process In other cases, the fibrinous adhesions that were present become organized to form fibrous bands fastening together adjacent coils of bowel or omentum and bowel, or cementing these structures to the abdominal wall. These fibrous adhesions may cover broad surfaces or may be stretched out into the form of single or multiple cords and predispose to bowel obstruction.

Chronic Peritonitis This is usually tuberculous in origin, but other types of infection, such as that seen in actinomycosis may occur In tuberculous peritonitis there is usually a large amount of clear fluid present in the abdominal cavity and the peritoneal surfaces are peppered with small elevated nodules the tubercles Less frequently the dry form of tuberculous peritonitis is seen. This is characterized by the presence of multiple dense adhesions, sometimes enclosing scattered tuberculous abscesses, and may resemble the peritoneal infection of actinomycosis. In both of these diseases there is also a strong tendency to fistula formation. In children, particularly associated with tuberculous peritonitis, there may be enlargement of the mesenteric lymph nodes due to tuberculous infection.

Abdominal actinomycosis is characterized by the presence of multiple adhesions and scattered abdominal abscesses and sinuses opening on the abdominal wall are common. The pus contains sulphur granules that are grayish yellow rounded bodies about the size of the head of a common pin.

Localized Intraperitoneal Abscesses

The most common cause of an intra-abdominal abscess is infection of the surrounding peritoneal cavity following a ruptured appendix. Such an abscess may or may not be palpable through the abdominal wall or through the rectum. Depending on the length of time it has been present, it may be walled off by adherent coils of bowel or may have a definite limiting membrane made up largely of fibrin. The diseased appendix

usually lies somewhere near the center of the abscess cavity but occasionally the appendix itself becomes walled off and the infection that had spread earlier may form an independent abscess in the pelvis, under the diaphragm, or elsewhere. Because of the longitudinal attachment of the mesentery of the small intestine and the anterior projection of the spinal column, infection originating on one side of the abdomen tends to travel up or down the corresponding lumbar gutter to reach the subhepatic and subphrenic areas above and the pelvis below

Another common cause of intra abdominal abscess is purulent infection of the Fallopian tubes An abscess of this origin is located in the pelvis where it may be felt by palpation through the abdominal wall or by vaginal examination. In the early stages the only finding may be fixation of the cervix and induration in the cul-de-sac, but later definite fluctuation may be detected. Because of the strong tendency of gonococcus infection to be associated with the formation of adhesions abscesses of this character nearly always remain localized, and secondary abscesses located elsewhere are seldom seen. A pelvic infection, on the other hand, that results from puerperal sepsis or from perforation of the uterus may be streptococcal in etiology and if an abscess forms at all its walls offer little protection against the spread of the infection

The perforation of an inflamed diverticulum of the colon may result in an abscess in the left lower quadrant or in the pelvis In fact an abscess in the left lower quadrant usually has its origin in the colon, either from a perforation of this character or as a result of the perforation of a benign or malignant ulcer of the bowel, but any pelvic abscess may advance to this region.

Rupture of a gangrenous gallbladder or a partly walled-off perforated ulcer of the duodenum or stomach, or the extension of an acute pancreatitis may result in the formation of an abscess below the liver in the right upper quadrant or epigastrium, and an infection from any of these sources or from a ruptured appendix rather often extends above the liver and produces a subphrenic abscess An abscess under the diaphragm may result also from the extension of an abscess of the liver or the extension of an empyema through the diaphragm. The subdiaphragmatic space is separated into right and left compartments by the coronary ligament and these are again divided into anterior and posterior spaces by the lateral ligaments. The lateral ligament on the left side lies so far back that the left posterior space is negligible. At least three-fourths of the subphrenic abscesses are located on the right side and most of them are on the posterior surface of the liver extending downward toward the right kidney and transverse colon. The left anterior space becomes infected usually as a result of the perforation of a gastric ulcer on the lesser curvature of the stomach, in general there is a tendency for a left subphrenic abscess to be of this origin and a right sub-

phrenic abscess to follow disease of the duodenum or appendix. The bare area of the liver is sometimes the site of an extraperitoneal abscess that is secondary to purulent infection of a retroperitoneal organ such as the kidney

Tumors of the Peritoneum

Primary tumors of the peritoneum are so rare that some authorities even doubt their existence, but secondary carcinoma of the peritoneum is very common. Metastatic lesions occur by direct extension from the original tumor by rupture and dissemination of the carcinomatous cells throughout the peritoneal cavity or by extension of the tumor through the blood stream. Often the peritoneal surface is studded with small nodules and these, with the increased peritoneal fluid nearly always present, make one think of tuberculous peritonitis. Following the rupture of a papillary cystadenoma of the ovary on the other hand, the second ary peritoneal growth may be papillomatous in appearance resembling the tumor in the interior of the original cyst. As a result of spilling or rupture of a pseudomucinous cyst of the ovary or a mucocele of the appendix, a peculiar condition known as pseudomyxoma peritonaei may appear and large more or less encapsulated, gelatinous masses are found throughout the peritoneal cavity

Tumors of the Mesentery

Secondary tumors of the mesentery are similar in appearance to those of the peritoneum Primary tumors of the mesentery although rare should be mentioned. Enterocystomas are cystic tumors located at the region of attachment of the mesentery to the bowel and may represent congenital outpouching of the bowel wall into the mesentery Although there is no communication between the cyst and the intestine they often have a common wall and the former may appear to be a duplication of the intestine. Such cysts contain clear mucoid fluid and are apt to be located near the terminal end of the ileum. Other cysts rarely seen are lymphatic cysts, which may be regarded as lymphangiomatas gas cysts which are small cysts containing gas producing cells and dermoid and hydatid cysts Solid tumors of the mesentery usually fibrosarcomatous in nature, are occasionally seen.

Diseases of the Omentum

Secondary carcinoma of the omentum occurs along with peritoneal in volvement elsewhere Cystic and fibrous tumors of the omental tissue similar to those of the mesentery are occasionally seen. Torsion or twist ing of the omentum with strangulation of the blood supply to the distal segment may occur spontaneously or as a result of the incarceration of a part of the omentum in a hernial sac. When the twisted portion lies free

in the abdominal cavity the usual sign of strangulation, an increased peritoneal exudate that later becomes pink and then bloody will be seen.

Diaphragmatic Hernia

Diaphragmatic hernias may be divided into two groups, congenital and acquired. Common sites of hernia in the congenital type are the foramen of Morgagni or parasternal orifice, the foramen of Bochdalek, the esophageal hiatus or a defect in the left half of the diaphragm. In a herniation through a defect in the diaphragm there is usually no sac present. A hernia that passes through the esophageal hiatus is covered by a sac, but the abdominal organs do not enter the pleural cavity but go into the posterior mediastinum.

The acquired type of diaphragmatic hernia may or may not be traumatic in origin. If not due to injury hernia may take place through either of the foramina named above or through the esophageal hiatus. Traumatic hernia is usually found in the dome or posterior part of the left side of the diaphragm and may be caused by any crushing abdominal injury or a penetrating wound of the diaphragm. In the congenital type of hernia, the stomach is usually the only abdominal organ involved, but occasionally the colon is drawn up along with the stomach. In acquired diaphragmatic hernia due to injury portions of the stomach, colon, small bowel and spleen may all be found in the pleural cavity

Retroperitoneal Tumors

Tumors arising from the retroperitoneal tissue as distinguished from those arising from the kidney, pancreas, and other retroperitoneal organs, are commonly malignant and are not easily classified. Two groups are usually identified, retroperitoneal lipoma and retroperitoneal sarcoma, but the former is by no means as innocent as its name might indicate. The lipoma, so called, is an infiltrating tumor that may contain areas of definite sarcoma. It is difficult or impossible to remove in many cases and has a strong tendency to recur The growth usually begins in the region of the kidney but may reach an enormous size. Retroperitoneal sarcoma begins commonly in the same location, grows insidiously and, by the time the surgeon sees it, is often inoperable. The tumor may be entirely solid but as a rule it contains single or multiple cysts, one or more of which may reach very large size

Benign tumors, such as fibroma, myxoma, or true lipoma, occur in retroperitoneal regions and offer a better chance for complete removal.

Tumors of the Adrenal Gland

Nodular hyperplasia of the adrenal gland is commonly seen and produces no symptoms. The nodule which is usually yellowish in color

rarely becomes larger than a pea. Carcinoma of the adrenal, resembling in structure carcinoma of the kidney is the most common tumor of the adrenal, and its clinical course resembles that of the kidney tumor True adenoma of the adrenal is rare but does occur and such a tumor when located in the cortex may produce early development of the secondary sex characteristics in a child, and hirsutism and virilism in the adult female. Benign adenoma of the medulla, or paraganglioma, may be associated with paroxysmal hypertension Neuroblastoma may develop in the medulla of the gland or in the near by sympathetic ganglia. Tumors of this type run a rapid course, often metastasize to the bones and liver and the diagnosis is seldom made before the condition is hopeless.

TREATMENT AND TECHNIQUE

Generalized Peritonitis

Although the indications for operation in generalized peritonitis are, properly speaking, beyond the scope of this book, it may be said that the treatment must be individualized. When the condition has been present for some time and paralytic ileus with abdominal distention, dehydration, low blood chlorides and alkalosis are present, it is obvious *that surgery is out of the question until the patient s condition has been* improved. When the patient is seen early it may be impossible to be certain that generalized peritonitis is present until the abdomen has been opened, operation in these cases should most certainly be done It is in that group in which generalized peritonitis is unquestionably pres *ent and yet paralysis of the bowel has not occurred that increasing reli* ance is being placed on antibiotics, and surgery is being deferred. The decision whether or not to operate is one that places a great responsi bility on the surgeon. Not only must the condition of the patient be con sidered but also the nature of the lesion. For example, generalized peri *tonitis due to gangreoous bowel offers little chance for cure with opera* tion, but without operation the condition is hopeless When a perforated diverticulum of the sigmoid is the primary focus, closure of the opening may be difficult, or it may be found at operation that nature has already sealed off the perforation by adhesions. Generalized peritonitis resulting *from the perforation of a malignant ulcer of the stomach or colon offers* such a bad prognosis that surgical interference is seldom undertaken.

Assuming that operation has been decided on, there is usually in the history or physical findings some information obtainable so that the surgeon is reasonably sure of the cause of peritonitis. If it is due to a ruptured appendix, and paralytic ileus with distention of the bowel is not present, an incision should be made in the right lower quadrant and the appendix removed, if this can be done without too prolonged and extensive a procedure. If the appendix is not readily accessible and

cannot be removed without considerable handling of the bowel, the gion of the appendix should be drained. A muscle-splitting incision these cases will give the strongest abdominal wall and the most dir approach to the appendix.

If the origin of the peritonitis is a ruptured gallbladder the usual g bladder incision should be made and the organ removed.

A perforated ulcer should be closed and drainage may be institu to the region. If perforated or gangrenous bowel is present, the perfo tion should be closed or the gangrenous segment exteriorized or moved. A perforated diverticulum of the colon should be removed a the base closed by a few sutures Cases of gonococcal infection sho receive penicillin therapy and surgical attack is not indicated. The pe tonitis resulting from the widespread infection by streptococci seen puerperal sepsis or following an abortion is also not improved by sur cal interference. Peritonitis due to the pneumococcus has been reliev in the past by opening the abdomen and instituting drainage, but present penicillin therapy is preferable and operation should be reserv for localized abscesses which persist. Tuberculous peritonitis has be cured in many cases by simply opening the abdomen, removing the fl by suction and then closing it again but it is doubtful if this proced has any advantage over simple aspiration. Drainage should not be stituted because, although the fluid may re-form in a relatively sh period of time, it can be controlled by paracentesis until recovery ta place as it does in at least half the cases

Abdominal Actinomycosis

Penicillin therapy is often very effective in this disease and surgi intervention is required only occasionally to drain abscesses. The pr fuse dense adhesions and the tendency of the abscesses to be multi and widely distributed make the procedure difficult.

Localized Intraperitoneal Abscess

The fundamental principle to be observed in draining any intra-a dominal abscess is to insert drains without spreading the infective p to other parts of the abdominal cavity This is accomplished by a proaching the abscess at the point where it is nearest to the abdomin wall and by protecting the neighboring coils of bowel with gauze drain an appendiceal abscess, for instance, a McBurney incision is ma at the usual position to approach the appendix, unless the abscess c be felt in another location. The peritoneum is incised with the great of care and one should always bear in mind that the bowel may adherent to its under surface When the peritoneum has been opene moist gauze packs are carefully inserted to wall off the region and th finger is insinuated gently between the coils of bowel held together

fibrin. A relatively fixed area of bowel will be palpable and as soon as one loop of bowel is separated from this mass it is packed off with gauze. When the finger enters the abscess cavity a suction tube should be used to remove the pus that wells out. If the source of the pus is not too far in, it is justifiable to separate the coils of intestine a little more and attempt to remove the appendix. If this can be done the operation should be performed with strict attention to the protection of the neighboring intestine, with minimum manipulation, and with as much speed as is consistent with care and safety If the appendix cannot be removed, one or two Penrose drains should be placed in the abscess cavity and left there for several days until the drainage becomes less in amount and more serous in character

Subphrenic Abscess

The method of draining an abscess just described is applicable to an intra-abdominal abscess in any location, but there are some special considerations in connection with subphrenic abscess in particular Not all subphrenic infections require surgery as many subside under penicillin therapy If pus forms and drainage is necessary it may be approached from in front or behind and on the right or left side, depending on its location, the most common approach being the right posterior A transpleural approach to a posterior abscess may be made by resecting about 5 cm. of the tenth rib making a longitudinal incision in the posterior periosteum, and separating it from the underlying parietal pleura. The wound may be packed with gauze and after a few days when adhesions have taken place between the parietal and the diaphragmatic pleura, an incision is made through pleura and diaphragm and a drainage tube inserted. This two-stage procedure is rarely used at present, but as a safeguard in a one-stage operation, before an incision is made through the pleura to insert the tube a circular suture may be put in around the area of the proposed incision to hold the two layers of pleura together The tube, of course, passes through the two layers of pleura and the diaphragm. Another method of extraperitoneal drainage described by Ochsner and Graves,[1] entails the resection of the entire twelfth rib (Figure 81, B and C) A transverse incision is then made at right angles to the spine at the level of the spinous process of the first lumbar vertebra and extending across the bed of the rib (Figure 81D) in which region the incision should be below the level of the pleura. The kidney is displaced downward and the finger is insinuated upward between the peritoneum and the under surface of the diaphragm (Figure 81A) until at or near the dome of the liver the finger can be pushed into the abscess cavity One or two rubber tubes are then passed into the cavity and fixed

1 Ochsner A., and Graves, A. M 'Subphrenic Abscess, *Ann. Surg* 98 961 1933.

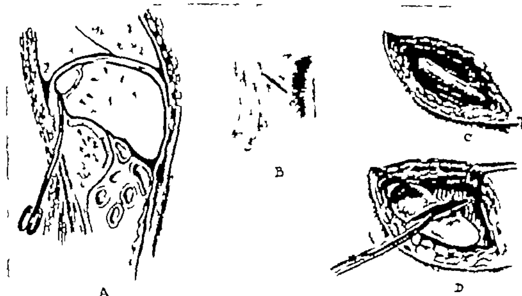


Fig. 81 *Drainage of Right Posterior Subphrenic Abscess (Method of Ochsner and Graves)* B Incision C. Exposure of twelfth rib D Rib has been resected and a transverse incision has been made across its bed. The finger or an instrument is passed through the incision and upward to locate the abscess, as shown in A.

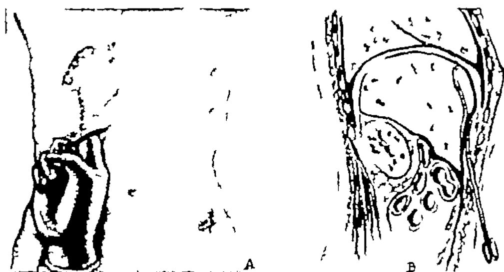


Fig. 82 *Drainage of Right Anterior Subphrenic Abscess* A. An incision has been made parallel to the costal margin down to the peritoneum The finger or an instrument is passed upward to locate the abscess, as shown in B.

in place by suturing them to the skin. An abscess under the anterior surface of the diaphragm may be approached extraperitoneally by making an incision through the anterior abdominal wall, parallel to the costal margin, down to the peritoneum. The finger then strips the peritoneum from the ribs and diaphragm until the abscess cavity can be reached with a hemostat and opened (Figure 82)

Cysts and Tumors of the Mesentery

Primary tumors of the mesentery should be removed, if necessary sacrificing a segment of bowel and performing an end to-end anastomosis. Metastatic tumors of the peritoneum or mesentery cannot be dealt with surgically, but the large intraperitoneal masses of pseudomyxoma peritonaei should be scooped out of the peritoneal cavity and the primary tumor should be removed if possible. The condition will probably recur, but the patient may be given a comfortable extension of life, and in some cases a second and a third operation can be done

Diseases of the Omentum

When a primary tumor or torsion of the omentum is present the affected segment should be resected.

Diaphragmatic Hernia

Many patients with diaphragmatic hernia, usually those in which a portion of the stomach has passed through the diaphragm, have few or no symptoms and operation may not be indicated. However if a small hernia of this type should be found in the course of an operation for some other disease, since the location of the incision will not be suitable and the repair of the diaphragm is a major procedure in itself and should often be preceded by paralysis of the diaphragm by crushing the phrenic nerve, it is not advisable to attempt the operation at that time.

When operation is indicated, as it usually is in traumatic hernias and whenever significant symptoms are present and the patient's condition will stand an operation, preliminary paralysis of the diaphragm produced by crushing the phrenic nerve aids considerably in relaxing the diaphragmatic muscle so that the edges of the opening can be approximated without tension, phrenicectomy alone may be useful as a palliative measure in some inoperable cases. Operative repair of the hernia may be undertaken by either the abdominal or the thoracic approach, but I believe the thoracic route to be easier and no more dangerous. In occasional cases a combined thoracic and abdominal operation may be necessary

To approach the diaphragm by way of the thoracic cavity the patient should be placed on the side opposite the location of the hernia, usually the right, and positive pressure anesthesia should be used. An intercostal incision is made in the seventh intercostal space, beginning at the costochondral junction and extending backward as far as the posterior axillary line. The ribs are separated by strong retraction and a self retaining retractor is inserted. The herniated viscus should be replaced in the abdomen, cutting adhesions as may be required, and the opening in the

diaphragm should be closed by imbricating the edges and suturing them with interrupted sutures of heavy silk. The ribs are held together by passing several heavy catgut sutures around the seventh and eighth ribs, as the last of these is tightened, a hemostat is placed in the opening to allow the expulsion of air as the anesthetist expands the lungs A continuous suture of catgut is now used to suture the intercostal muscles and the muscles of the chest wall, and the usual dermal suture is used for the skin.

When the abdominal route is chosen, as it should be in hernia through the esophageal hiatus when the abdominal viscera are in the posterior mediastinum, a long incision is made starting at the xiphoid process and extending along the costal border A wide retractor is inserted to pull the chest wall outward, and the left lateral ligament of the liver is cut with scissors and the liver pulled aside. The opening in the diaphragm is identified and, if gentle tension does not return the viscera to the abdomen, the diaphragmatic opening may be enlarged. Occasionally it may be necessary to pass the hand upward alongside the viscera and loosen adhesions Since a sac is present in hernias of this type, it must be cut from its attachments to the stomach and diaphragmatic opening before the hernia is repaired. Whenever possible the hernial opening should be repaired by overlapping the muscle of the diaphragm. If there is too much loss of structure, transplanted fascia lata may be used to close the defect.

Retroperitoneal Tumors

A large tumor located in the upper abdomen may present a difficult diagnostic problem, and the surgeon is sometimes called upon to perform an abdominal exploration for an upper abdominal tumor or cyst of unknown origin. Both the retroperitoneal sarcoma and lipoma may be cystic, but they are characterized by being densely fixed at their point of attachment, so that one usually has no difficulty in deciding that he is dealing with a malignant growth. In many instances it is quite evident that the tumor is inoperable A pancreatic cyst is usually monolocular whereas the cystic retroperitoneal tumors are multilocular sometimes resembling in appearance a multilocular cyst of the ovary but usually containing more solid tissue. Sometimes however one or more of the cysts in a retroperitoneal sarcoma may be so large as to dwarf the rest of the tumor and this is true also of carcinoma arising from the kidney I recently operated on a patient with carcinoma of the kidney in which a cyst arising from the tumor contained over 5 liters of fluid. When such a large cyst is present it is justifiable to marsupialize it if the entire tumor cannot be removed. If a retroperitoneal malignant tumor is solitary and appears to be movable and accessible an attempt should be made to dissect it out, since even partial removal may prolong the patient s life.

Tumors of the Adrenal Gland

If there is good reason to suspect the presence of an operable tumor of the adrenal gland it may be difficult to determine clinically even with air injection, which gland is involved and it may be necessary to examine both. The patient is placed in a prone position on the table so that bilateral incisions corresponding to the upper half of the usual nephrectomy incision can be made. Beginning on one side the skin fascia, and muscle are incised down to the level of the twelfth rib the costovertebral ligament is cut and the twelfth rib is elevated The perirenal fascia is opened, the kidney is grasped and pulled down, and the fat around the adrenal gland is carefully separated The gland is examined and palpated, and if a tumor is found the vessels are caught and tied and a portion of the gland, or the entire gland, is removed If no tumor is found in the first adrenal examined, a similar procedure is done on the other side. Both wounds are closed by suturing the muscles with catgut and the skin with interrupted sutures of silkworm gut It is advisable to leave a soft-rubber drain in place for a day or two to take care of any serum or blood that may collect in the perirenal space

If a tumor of the adrenal gland is very large, or if it should be found in an abdominal operation, it may be removed by the abdominal route after first mobilizing the colon as described under nephrectomy (page 558)

POSTOPERATIVE CARE

Fluids chlorides and proteins together with glucose are provided until the patient is able to take adequate nutrition by mouth. The Wangensteen or Miller Abbott tube is utilized until peristalsis is established, and enemata, the rectal tube and pitressin should be used as indicated. Oxygen should be given for cyanosis, and the danger of pulmonary atelectasis is minimized by breathing exercises and frequent change in the position of the patient. Penicillin therapy should be continued to combat the infection. A pleural effusion may develop after an operation that disturbs the diaphragm, but this fluid should be aspirated only if it embarrasses respiration and shows no sign of being absorbed in a reasonable length of time. After the removal of a paraganglioma of the adrenal, the blood pressure should be taken at frequent intervals and adrenalin or ephedrine administered as necessary to combat extreme depressions. Drains should be removed from abscesses when the drainage lessens in amount and loses some of its purulent character this usually occurs after about a week. The usual measures for the treatment of tuberculosis should be used when tuberculous peritonitis is present.

CHAPTER XII

The Liver

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The Liver

The Liver

Because of the nature of the most common diseases of the liver surgery finds limited scope in the treatment of this organ On the other hand, because it is so frequently diseased it is extremely important for the surgeon to be able to recognize the nature and appearance of its various lesions. Exploration of the liver is done, or should be done, in all abdominal operations unless there is danger of spreading an acute infection. Cancer of any part of the gastro-intestinal tract so commonly metastasizes to the liver that no operative procedure for the cure of the original cancer should be instituted until the liver has been examined. The presence of a lump or nodule on the liver does not however necessarily mean that this nodule is cancer As will be mentioned below there are several diseases of the liver that produce nodules, and all of these must be kept in mind during the operation.

PREOPERATIVE TREATMENT

The patient with severe liver damage of an acute nature is very sick and usually needs blood transfusions and restoration of fluid and electrolytes. Hypoproteinemia, so commonly present, should be corrected, and glucose should also be administered. In chronic disease of the liver whether or not accompanied by jaundice hypoprothrombinemia may exist and should be treated by the administration of vitamin K and bile salts. Pyogenic or actinomycotic infections should be treated by penicillin and amebiasis by emetine

INCISION

The liver is most commonly approached through a right rectus or a right paramedian incision, but a transverse incision in the upper abdomen is also satisfactory In rare instances it may be desirable to use a trans pleural approach, such as is described under subphrenic abscess (page 231) or an extraperitoneal approach below the posterior margin of the ribs.

EXPLORATION

The hand is passed over the dome of the right and left lobes of the liver noting its size and searching for irregularities adhesions or areas of fluctuation By making traction on the round ligament the lower surface may be pulled up and examined visually The common association of disease of the spleen and liver makes it doubly important to examine the spleen, and the incidence of the liver disease as a result of cholecystitis and its complications is so high that the investigation of the biliary system should be carefully done The stomach duodenum and pancreas should be palpated and the hand should be inserted down into the pelvis to investigate the condition of the bowel the uterus and its appendages If what appears to be carcinoma is found in the stomach or bowel, and nodules that appear to be metastasis from the tumor are found in the liver a small piece of one of these nodules may be excised and examined immediately under the microscope Metastatic carcinoma of the liver usually precludes operation on the original tumor but in exceptional cases, particularly when obstruction can be relieved and when the metastasis is not too extensive and is apparently confined more or less to the liver a radical operation may be justifiable. The presence of ascites in association with carcinoma is usually an indication that the tumor is inoperable, but other conditions that are amenable to surgery may produce ascites. Among these are benign cyst of the ovary atrophic or nodular cirrhosis, and tuberculous peritonitis. In the latter condition the surgical treatment is confined merely to opening the peritoneal cavity and the diagnosis should be evident when the nodules of tuberculosis are noted on the coils of bowel and the peritoneal surface of the abdominal cavity but it is well to remove one or more lesions for biopsy

LESIONS OF THE LIVER

Cirrhosis

Deposition of connective tissue in the liver with partial destruction of the parenchyma may be caused by a number of known factors which it is not necessary to elaborate here In some cases the cause of the condition is unknown. Of surgical importance is the fact that cirrhosis may be the result of obstruction of the common duct with cholangitis, or may be caused by infection without obstruction In the latter case it is apt to be associated with disease of the gallbladder Enlargement of the liver may be encountered in obstructive jaundice hepatitis cholangitis and hypertrophic biliary cirrhosis. In these conditions jaundice is usually present. Prolonged obstruction of the common duct, or prolonged infection with increase in the amount of connective tissue and progressive destruction of the liver cells leads to a shrinkage of the organ. With this progressive

diffuse scarring, the surface of the liver becomes irregular in hypertrophic biliary cirrhosis taking on a finely granular appearance and in obstructive biliary cirrhosis becoming more nodular The extreme result of connective-tissue replacement together with the new growth of islands of liver cells is seen in nodular or atrophic cirrhosis Here the liver is small and may be very much deformed, and the surface is studded with rounded masses varying in size from a half to several centimeters in diameter This type of cirrhosis, which is of unknown etiology is commonly associated with ascites and frequently with enlargement of the spleen, and jaundice may or may not be present. Distended veins around the umbilical region are evidence of the development of collateral circulation.

Thickening of the capsule of the liver in the region of a diseased gall bladder with slight irregularity of the liver surface in this region, is largely due to a local perihepatitis although there may be superficial destruction of the liver cells with scar tissue replacement, the condition should not be mistaken for cirrhosis

Tumors of the Liver

Primary tumors of the liver are not common, but, of the benign tumors, cavernous hemangioma is most often seen. It forms a rounded, rather soft mass usually in the left lobe, and may reach large size. The tumor is made up of a mass of vascular spaces filled with blood. It cannot be shelled out of the liver tissue, but is intimately attached to it and communicates with it by large blood vessels.

Adenoma of the liver is an uncommon tumor usually small in size slow growing, and either single or multiple. The adenoma is a benign tumor but it cannot be removed without cutting out some of the surrounding liver tissue.

Primary carcinoma of the liver is seen most often in a cirrhotic liver The tumor grows rapidly and may reach large size, and metastasis may take place within the liver itself and elsewhere. Carcinoma of the liver is firm grayish in color or sometimes bile-stained, and cannot be separated from the liver tissue.

Primary sarcoma of the liver is a rare tumor that grossly resembles carcinoma and that follows a similar rapidly fatal course.

Metastatic tumors of the liver are extremely common. Carcinoma, sarcoma, melanoma, or other tumors metastasizing by way of the portal system and carcinoma of the lung, breast, or other organs, and sarcoma spreading by way of the blood stream all may establish secondary tumors in the liver These metastatic nodules have the same general appearance as the primary tumor They are usually firm, rounded, and grayish in color and the extent of the secondary growth may vary from one very small nodule to dense masses that almost seem to replace the organ.

Infectious Granuloma

Tertiary syphilis in the form of a gumma or as diffuse scarring and deformity (hepar lobatum) is becoming an increasingly rare disease. Gummata may be single or multiple, and appear as sharply demarcated rounded lesions that look gray on cross section.

Single or multiple conglomerate tubercles, often 2 or 3 cm. in diameter are not uncommon. Generalized miliary tuberculosis usually affects the liver and produces pinhead sized gray-to-white lesions profusely distributed throughout the organ. The conglomerate tubercles or tuberculomas resemble a gumma, but calcification is more common in the wall and the caseous content resembles that in other tuberculous lesions.

Abscesses

A large abscess of the liver forms a soft fluctuating mass and, unless deeply situated, the surface of the liver over it is apt to be covered with fibrin and the liver is often adherent to surrounding structures such as the diaphragm and the abdominal wall. Small abscesses may be very numerous and distributed throughout the liver appearing on the surface as yellowish-gray rounded, sharply defined areas. A very common type of hepatic abscess is that of pyemic origin, which is so commonly associated with pylephlebitis. Pyemic abscesses are apt to be multiple and comparatively small, but sometimes many small abscesses may coalesce to form a large cavity filled with pus. A second type of multiple small abscesses is that due to cholangitis or pericholangitis. These occur as the result of obstruction and infection of the common duct, and may produce enlargement of the liver or be associated with biliary cirrhosis. The patient is usually jaundiced. Abscess of the liver may be the result of direct extension from an abscess under the diaphragm or from suppuration in the gallbladder or other adjacent viscus. Another type of abscess not infrequently occurs in association with amebic dysentery These abscesses are often single and are found most commonly in the upper portion of the right lobe, so that the liver is pushed downward by the increasing size of the mass The contents, instead of being the usual, foul smelling yellow pus, are apt to be chocolate-colored and odorless. The interior of the cavity is characterized by the ragged walls and there is only a limited amount of connective tissue separating the abscess from the surrounding liver Another type of liver abscess is that produced by actinomycosis, but this is rare and is apt to be associated with actinomycosis elsewhere in the abdominal cavity There is enlargement of the liver and the pus contains sulphur granules

Cysts of the Liver

The most common large cyst of the liver and it is a comparatively rare disease, is the hydatid cyst produced by the taenia echinococcus, the small

est of the tapeworms The content of a hydatid cyst is a mucoid fluid in which round daughter cysts float freely or are attached to the wall of the parent cyst. Occasionally the larvae die and the contents then become changed to a putty like mass The outer wall of the cyst is connective tissue but within this is a white laminated chitinous wall. Echinococcus cysts may be single and very large, or they may be small and scattered throughout the liver

There are a number of types of congenital cysts of the liver all of which may be single or multiple Among them are cystic degeneration of the liver which is so commonly associated with congenital cystic kidneys, bile-retention cysts and lymph retention cysts. The lymph and the cystic degeneration types of cysts may reach considerable size, and in the latter condition a mass of cysts apparently almost replaces the liver tissue.

Injury to the Liver

In any crushing injury to the body or any blow on the abdomen, the liver is very apt to be torn. When the peritoneal cavity is opened there is seen to be free blood present, and, on exploring the surface of the liver a blood clot is usually found in the region of the damage. Associated with such an injury of the liver there is apt to be some injury of the spleen, bowel or pancreas and these organs must be carefully investigated because of the possibility of multiple lacerations.

TREATMENT

When ascites is observed as the peritoneal cavity is opened, its origin should be determined. If it is due to a tumor of the ovary the incision should be enlarged downward and the tumor removed. If tuberculous peritonitis is present, further exploration is not indicated, and after biopsy the abdomen should be closed without drainage If the fluid is due to metastatic carcinoma, it does no harm to make attempt to determine where the primary tumor is and, if possible, obtain a piece of it for microscopic examination If the ascites is due to nodular cirrhosis, the Talma Morison operation may be performed. In general, when ascites is present, drainage of the abdominal cavity should be avoided.*

When a nodule is present in the liver and its nature is in doubt, one should remove a small piece of it for examination Occasionally when the tumor is located near the edge of the liver the entire tumor may be safely removed A single tumor in any part of the liver if it is accessible, not too large and not due to metastatic cancer should be resected. Occasionally it is possible to resect a large hepatic tumor when it is located in the left

* Favorable results have been reported recently on direct anastomosis between portal and systemic veins, utilizing usually the splenic and renal vessels (portocaval shunt)

obe, where this can be done without cutting through too much liver issue. A single tuberculoma should be removed if possible and if there s no evidence of active tuberculosis elsewhere.

Multiple abscesses of the liver unless they are due to obstruction of he common duct by a stone, are not directly amenable to surgical treat nent, but it may be possible to treat a primary focus such as a pelvic peri onitis. Single large abscesses not due to amebae should be drained

Large cysts of the liver may be removed by enucleation or drained by narsupialization.

Lacerations of the liver should be sutured, or if there is extensive loss or maceration of the liver tissue, the area may be packed and the pack held in place by catgut sutures through the liver

TECHNIQUE

Excision of Tumor

Any incision into the liver tissue is followed by considerable bleeding and drainage of bile, and the resection of large tumors of the liver is for this reason not often possible. It is, however a simple matter to excise a V-shaped wedge from the edge of the liver controlling the bleeding by pressing on the lobe of the liver with the fingers until the larger vessels are controlled by suture ligature and the two cut surfaces are brought together with through-and-through sutures of catgut. Absorbable gauze applied to the oozing surface is a valuable hemostatic agent. If it is so desired, before the resection is done, through-and-through hemostatic sutures may be introduced around the area of proposed resection and tied before the liver is cut. The liver tissue is extremely friable and only the lightest pressure can be used in making ties. If the nodule to be removed does not lie on the edge of the liver a wedge-shaped block containing the tumor may be removed and the same principle utilized in closing the defect. The cautery can sometimes be used effectively to control hemor rhage, and the incision in the liver made with a narrow cautery blade.

Suture of Laceration

Lacerations of the liver are sutured by the method described above. Many times when the operation is performed, the hemorrhage from the liver has already ceased, and after the removal of the blood from the peritoneal cavity it is evident that no suturing of the liver is necessary Sometimes, on the other hand, the hemorrhage is so profuse that all one can do is insert a pack or absorbable gauze to make pressure on the bleeding surface and close the peritoneal cavity as quickly as possible. In any operation where there may be leakage of bile the peritoneal cav ity should be drained by one or two Penrose drains inserted toward the doubtful area.

Talma Morison Operation

The purpose of this operation is to improve the communicatio tween the systemic and portal circulations but the procedure is of c ful value The abdomen is usually opened through a right upper- incision or through a paramedian or midline incision above the umb The fluid is emptied from the peritoneal cavity by suction. The surface of the liver and the lower surface of the diaphragm are r with gauze to promote adhesions. The greater omentum is then lift and may be sutured inside the abdomen to the parietal peritoneum portion of it may be brought through the peritoneum and sutured t rectus sheath, either in front or behind the rectus muscle. Whe omentum is brought out through a peritoneal opening care must be not to suture the peritoneum so tightly around the omentum as t off its blood supply nor must the opening be left so large as to pr the development of a hernia

Echinococcus Cyst

The abdomen is entered through a right upper-rectus incision. protecting the abdominal contents by a moist gauze pack, the c aspirated Emptying the cyst aids a great deal in handling it and c mining whether or not it can be entirely removed. If the attachme the cyst is not too extensive and if by experiment it has been found it can be shelled out without too much hemorrhage from the live cyst should be completely removed. If this cannot be done, the cyst be opened, the chitinous lining removed, and the cyst closed a Usually however one must be content to marsupialize the cyst or excision of a portion of it, the remainder can be marsupialized. Aft opening in the cyst is made the edges are grasped with forceps and in place while the cyst wall is sutured to the peritoneum. A tube of caliber is then inserted in the cyst and anchored in place by a penetr suture of catgut. This will serve to keep the opening of the cyst p until healing has occurred between the cyst wall and the peritoneum. layers of peritoneum, fascia, and skin are closed by the usual me Five per cent formaldehyde may be injected into the cyst in ord kill the remaining scolices. After a number of months or years, d which drainage has occurred more or less intermittently it may be sible to operate again and remove the remaining portion of the cyst less difficulty

Pyemic and Cholangitic Abscesses

These are usually multiple abscesses and cannot be treated by drain Attention should be directed to the common bile duct to be sure there is no obstruction when there is a pylephlebitis, the region of

appendix should be investigated to be sure that there is no primary source of infection still present.

When a large single abscess presents on the upper surface of the right lobe of the liver it may be advisable to approach it by a thoracic route as described in the treatment of subphrenic abscess (page 231) Most commonly however the incision will be in the upper right or left rectus muscle with the usual exploration of the liver If an abscess is not apparent on the surface of the liver a needle may be inserted in various directions until it is found. After the abdominal cavity is packed off a pointed forceps is inserted along the path of the exploring needle When it is opened and withdrawn pus will pour out. One or two Penrose drains should be inserted in the abscess cavity If there is much bleeding the cavity may be packed with gauze When the abscess cavity does not lie too deeply a finger may be inserted into the cavity to break down any septa that would tend to wall off portions of the abscess

Amebic Abscess

Such an abscess should be treated by emetine but if this treatment is not sufficient the abscess should be aspirated one or more times. If an amebic abscess is found during the course of an abdominal operation, its nature will be evident from the character of the contents withdrawn through a needle. Only when secondary infection has taken place as shown by culture of the pus or by a foul odor should drainage be instituted.

Actinomycosis of the Liver

Surgery in this condition should be confined to opening and draining the abscess. Because of the nature of the disease, with its extreme tendency to form adhesions and walled-off pockets of pus there may be multiple abscesses scattered throughout the peritoneal cavity By blunt dissection, adherent omentum is removed from the surface of the liver and if necessary an aspirating needle may be inserted to locate the pus A hemostat is pushed into the abscess and the usual drainage is instituted. The patient will require penicillin treatment to prevent the advance of the disease

POSTOPERATIVE CARE

Vitamin K and bile salts should be continued, and fluids, protein, and glucose should be administered. Blood transfusions may be necessary especially when there has been a traumatic lesion. A drain left in an abscess of the liver can usually be removed in five or six days. A tube inserted into a marsupialized cyst is taken out when the stoma is well healed, usually in about ten days.

CHAPTER XIII

The Gallbladder and Bile Ducts

PREOPERATIVE TREATMENT

INCISION

EXPLORATION

EXPOSURE AND EXAMINATION OF THE GALLBLADDER

LESIONS OF THE GALLBLADDER

- Anomalies of the Gallbladder
- Acute Cholecystitis
- Chronic Cholecystitis
- Tumors of the Gallbladder

THE BILE DUCTS

- The So-Called White Bile
- Stones in the Common Duct
- Internal Fistulas
- Common Duct Stricture and Atresia
- Carcinoma of the Bile Ducts
- Biliary Dyskinesia

TREATMENT

- Anomalies of the Gallbladder
- Acute Cholecystitis
- Chronic Cholecystitis
- Stones in the Common Duct
- Internal Fistula
- Carcinoma of the Bile Ducts
- Stricture and Atresia of the Bile Ducts

TECHNIQUE

- Exposure of the Common Duct
- Cholecystectomy
- Cholecystostomy
- Choledochostomy

The Gallbladder and Bile Ducts

In surgery of the gallbladder and bile ducts, it is extremely important, perhaps more so than in any other abdominal operation to make a careful study of the general situation before undertaking any procedure Not only must the gallbladder the cystic duct, the several portions of the common duct, the hepatic duct, the liver and the pancreas be examined, but the condition of adjacent organs particularly the stomach and the duodenum, must be investigated and the findings must be correlated to the patient s general condition and to the history of the illness with particular reference to jaundice. All of these factors furnish variables that result in an almost infinite variety of problems to be met and, although no universal procedure can be prescribed, it is obvious that some attempt at systematization is essential.

• PREOPERATIVE TREATMENT

The glycogen content of the liver should be built up by a high carbohydrate diet reinforced, if necessary by glucose given intravenously The serum protein content should be raised by large quantities of protein in the diet, and amino acids should be given parenterally if necessary Blood transfusions should be given when indicated for anemia or sepsis and they add to the protein supply of the body Serum bilirubin determinations by the Van den Bergh method give useful information about the degree of jaundice which helps in choosing the best time for operation. Surgery should be performed when the serum bilirubin value is lowest, if the jaundice is intermittent, or when the serum bilirubin is falling or remaining stationary It should be avoided as a rule when the serum bilirubin content of the blood is rising but in some cases operation cannot be delayed and must be performed in spite of increasing jaundice. The normal serum bilirubin is up to 1.2 mg per 100 cc. and jaundice becomes apparent with values above 1.5 mg

Liver function tests may be utilized, as they often afford helpful information on the optimum time to operate and the probable risk of the operation.

In the patient with acute cholecystitis or common duct obstruction, as vomiting may have reduced the fluids and chlorides, and acidosis may be present, intravenous saline solution should be given If acute cholangitis is present, it is usually advisable to defer operation until the temperature approaches normal. The renal function should be investigated, particularly in the jaundiced patient, and in the presence of an elevated non protein nitrogen urinary albumen, and decreased kidney function, operation should be postponed until this can be improved by intravenous fluid and glucose.

The prothrombin content of the blood should be determined, if it is low, or the patient is jaundiced, synthetic vitamin K together with bile salts should be administered. If the vitamin K is given intramuscularly in the water soluble form, bile salts need not be administered. When synthetic vitamin K (2 methyl 1–4 naphthoquinone) is given by mouth, 2 to 3 mg daily plus 2 gm. of desiccated bile salts should be used. Ordinarily three days of this medication is sufficient to bring the prothrombin up to normal. If the patient cannot take medicine by mouth because of vomiting, the water soluble drug is given hypodermically in the amount of 1 cc. daily for three days. The prothrombin time must be checked before operation, since in some cases vitamin K may not be effective in these fresh blood or fresh plasma must be administered.

INCISION

There are a number of satisfactory incisions in common use in operations on the biliary system. The right rectus incision, with or without an extension inward to the region of the xyphoid cartilage is the most popular and is entirely adequate. A transverse incision across the rectus muscles provides excellent exposure and preserves the nerve supply An incision that is too long is a hindrance rather than a help, because considerable time will be consumed in trying to keep the bowel packed off so that it will not prolapse out of the abdomen. An incision about as long as the width of the surgeon s hand usually gives ample exposure. In very obese patients it may be advisable to make a longer incision in the skin than in the peritoneum, since in this way prolapse of the bowel is averted but good access is provided to the gallbladder

EXPLORATION

If no acute inflammation is present in the gallbladder the other abdominal organs should be systematically examined. The appearance of the edge of the liver near the gallbladder fossa should be noted. At this point grayish areas are commonly seen radiating outward. This is evidence not of cirrhosis but of perihepatitis and it is commonly associated with gallbladder disease. Blunting of the liver edge indicates a cirrhotic type of liver disease Enlargement or atrophy of the liver should be noted,

and any nodules that may indicate metastasis from a carcinoma should be searched for If the liver is very much enlarged, this may be some indication that the common duct is, or has been, obstructed. Enlargement of the spleen is occasionally noted under similar circumstances.

By grasping the greater omentum, the stomach is now pulled out of the wound and examined carefully visually and manually for evidence of ulcer or other lesion. The duodenum, the first part of which can be pulled out with the stomach, should also be examined, then, by the use of moist packs to keep the bowel out of the way the second part of the duodenum can be investigated. If a benign ulcer is found in the duodenum, the mere fact that the abdomen is open does not change the indications for ulcer surgery If a lesion is found in the stomach that is strongly suggestive of malignancy attention must be directed primarily to its treatment, unless acute cholecystitis or common duct stone is present, the gallbladder disease becomes of secondary importance. If jaundice is present and there is a malignant lesion in the stomach, the presumption is that the jaundice is due to enlargement of lymph glands in the lesser omentum or to the extension of the carcinoma to the lesser omentum, and search should be made in this area to see if such is the case. Cancer of the stomach that has progressed to the point of causing jaundice by metastasis to the neighboring glands or the lesser omentum should be considered inoperable.

The transverse colon, which has been pulled out of the wound with the greater omentum, should now be carefully examined, and with the left hand the ascending colon may be followed down into the right lower quadrant and the descending colon into the pelvis In general, any malignant or obstructive lesion of the colon will take first consideration in the surgery to be done.

The condition of the pelvic organs should be investigated. Ovarian cysts may be removed at the conclusion of gallbladder surgery by enlarging the incision downward, the risk of the operation not being greatly increased. Small fibroid tumors of the uterus may be noted but probably should not be disturbed. A hysterectomy for large tumors of the uterus can be done at the same time as a cholecystectomy but is with more safety postponed to a later date. If the appendix can be brought up into the abdominal wound, it may be examined and removed at the conclusion of the surgery of the biliary tract. If the patient is a young individual, the incision may be enlarged downward to remove the appendix, but in the older patients unless it is easily accessible it is well not to attempt to take it out. Acute or chronic inflammatory conditions of the pelvis must not be operated on unless it is apparent that they should take precedence over the gallbladder disease.

The general shape and size of the kidneys should be determined. Inflammatory disease, particularly of the right kidney has been more than once mistaken for chronic cholecystitis, and stones in the kidney have

been believed to lie in the gallbladder Surgery of the kidney for pyonephrosis should seldom be attempted by the transabdominal route if a mistake in diagnosis has been made, it is wiser to close the abdominal incision and make the usual lumbar approach.

EXPOSURE AND EXAMINATION OF THE GALLBLADDER

By using a large moist pack, the colon is now forced down below the level of the incision. A retractor is placed in the right upper margin of the incision and another pack is inserted to keep the stomach over towards the left. The next procedure is an extremely important one and can be termed the adjustment of the liver A clamp is placed on the falciform ligament, or two clamps may be used and the ligament cut between them. The assistant who holds the retractor to the surgeon s left is now given the clamp attached to the round ligament, and instructed to pull on it. The surgeon then inserts his left hand over the dome of the liver and makes pressure downward on the liver By these maneuvers the liver is displaced downward and turned outward, so that sometimes an operation that would otherwise have been performed in the depths of the abdomen becomes an almost surface procedure. An assistant now works a pack into the abdomen with one hand and pulls so as to make tension on the hepaticoduodenal ligament, thus bringing the common duct under tension.

Because of the nature of gallbladder *disease with its alternating periods* of quiescence and acute inflammation, there is a strong tendency toward the formation of fibrous adhesions, and the gallbladder may be found to be densely attached to the omentum, colon, stomach, or duodenum, it may only be after painstaking and prolonged dissection that it can be definitely identified. By the use of blunt and sharp dissection with the Mayo scissors, it is nearly always possible to clear away the adhesions, but in exceptional cases, where the gallbladder has been identified and little or no progress can be made in freeing it, the area may be packed off and an incision made in the gallbladder After spooning and sponging away the contents, a gloved finger may be inserted into the gallbladder and, with this as a guide, the adhesions can be rapidly cut.

LESIONS OF THE GALLBLADDER

Anomalies of the Gallbladder

The gallbladder may be entirely free from the liver and covered by peritoneum over its entire surface except at the point where the cystic vessels approach it here there may be what corresponds to a mesentery Another anomaly is that in which the gallbladder is almost entirely embedded in the liver Variations in the blood supply of the gallbladder are numerous and common

Acute Cholecystitis

Early in the catarrhal form of the disease the gallbladder may show no abnormality on inspection but will feel extremely tense. Later some redness of the wall will be apparent. In those cases of acute cholecystitis that are grafted on chronic cholecystitis, the usual changes produced by the chronic form of the disease will be evident. The gallbladder instead of having its normal bluish-green color and thin walls, will appear somewhat grayish and the walls will be thickened. In acute suppurative cholecystitis, the thickening may take an extreme form and the wall of the gallbladder may measure as much as 1 cm. The acute suppurative form of the disease may progress to a gangrenous cholecystitis, in which case the gallbladder walls will be dark red in color and extremely friable Any of the acute types of cholecystitis may be associated with hepatitis and cholangitis, which will be manifested by jaundice. Enlargement of the gallbladder is commonly seen in the acute suppurative cholecystitis and is associated with an obstruction of the cystic duct, due either to swelling of the mucosa of the duct or to the impaction of a stone in the duct. Because of the tenseness of the gallbladder it may be impossible to determine by palpation whether or not stones are present until the tension of the gallbladder is relieved by aspirating some of its contents. Even when no inflammation is present it may not be easy to express bile from the gallbladder when acute inflammatory changes are present in its walls it is not advisable to make too determined an attempt to palpate stones, since little information will be gained that will not be evident later

Chronic Cholecystitis

The chronic form of the disease is characterized by thickening of the gallbladder wall which results in its taking on a grayish color The organ may be normal in size or shrunken, and the disease may or may not be associated with the presence of stones. In the chronic catarrhal form, the gallbladder wall shows little gross change but if the process is of the cholesterosis type yellow cholesterin deposits may be noted on the folds of the lining (strawberry gallbladder) Not much significance can be attached to the type, number or size of stones in the gallbladder except that when small stones are present more attention if possible should be paid to the question of whether any stones are lodged in the common duct. It has been calculated that if stones are present in the gallbladder the chances are one in ten that stones will be found in the common duct. This figure was obtained without classifying the stones as single or multiple large or small and would have to be increased when applied to multiple small stones.

When the cystic duct becomes obstructed by a stone in the duct or inflammation of the duct, hydrops of the gallbladder often results. In this

condition the gallbladder may become enormously dilated and when opened will be found to contain clear mucus. The bile, which was formerly present, has been absorbed and the mucus represents the secretion of the glands of the gallbladder In the presence of infection the gallbladder becomes filled with pus (empyema) Enlargement of the gallbladder in general is a symptom of obstruction either of the cystic or of the common duct.

Tumors of the Gallbladder

With the exception of carcinoma and papilloma, tumors of the gallbladder are extremely rare. Papillomata, small pedunculated tumors developing from the mucosa, are commonly seen and usually cause no symptoms. They are often discovered only after the gallbladder has been removed. Carcinoma of the gallbladder may be a fungating growth of the mucosa, which fills up a large portion of the organ, or it may be an infiltrating lesion of the gallbladder wall. It may obstruct the cystic duct and cause the formation of hydrops. Frequently enlarged nodes will be seen along the cystic duct, or metastatic nodules will be evident in the liver since the tumor metastasizes early The only treatment available, cholecystectomy does not give a high percentage of cures. Although carcinoma of the gallbladder is not a rare lesion, a decision to remove the gallbladder should be on some other basis than the prevention of cancer

THE BILE DUCTS

Bile is conducted from the liver by means of the right and left hepatic ducts, which join together to form the common hepatic duct, about 2.5 cm. long This in turn is joined by the cystic duct, and below the juncture the duct is known as the common bile duct. The cystic duct is about 4 cm. long and the cystic artery usually runs along the left side of it, but anomalous positions of the artery are very common. The common duct, which is 7.5 cm. long and 7 mm. in diameter is divided into three portions. The first or supraduodenal part, which is about 3.5 cm. long, although it may be shorter than this if the cystic duct enters nearer the duodenum, runs downward along the right margin of the lesser omentum, with the hepatic artery to the left and the portal vein behind it. The second or retroduodenal portion passes behind the first part of the duodenum in front of the vena cava. By placing the index finger in the foramen of Winslow and the thumb on the front and lateral side of the duodenum, the presence of stones may be recognized in this portion of the duct. Usually stones found here can be milked upward into the first portion of the duct, but occasionally it may be necessary to incise the peritoneum along the lateral side of the duodenum and roll the duodenum inward to expose the duct. The third, or pancreatic, part of the duct grooves or tunnels through the

posterior surface of the head of the pancreas. About 2 cm. from the end of the common duct it is joined by the pancreatic duct of Wirsung, and the terminal portion of the common duct forms a dilatation known as the ampulla of Vater The point of entrance of the joined common and pan creatic duct into the duodenum is a projection of the mucous membrane known as the papilla of Vater which is located on the posterior and left side of the duodenum about 10 cm. below the pylorus. At this point, which lies in the second or descending part of the duodenum, there is a longi tudinal fold of the mucous membrane and the papilla is located at the upper extremity of this fold. If the duodenum has been opened, pressure on the gallbladder should force bile out of the papilla if no obstruction is present in the duct system.

The So-Called White Bile

The mucosa of the common duct contains no mucous glands, but there are special tubular glands in the duct which provide a thin fluid that dilutes the bile. The gallbladder mucosa, on the other hand, secretes a thick mucinous material. One function of the normal gallbladder is the concentration of bile· when such a gallbladder is in connection with an obstructed common duct there occurs a progressive thickening of the bile due to the gallbladder s concentrating activity so that after the lapse of several weeks the bile may be almost tarry in consistency Eventually the diluting tendency of the duct s secretion overcomes the concentrating activity of the gallbladder and the bile in the duct system and gallbladder is replaced by watery fluid. If there is an obstruction in the common hepatic duct or in both the right and left hepatic ducts, the gallbladder is no longer connected to the source of bile secretion and its concentrating mechanism cannot operate. The bilirubin of the bile is absorbed, and the epithelial cells lining the hepatic ducts secrete clear watery fluid. If on the other hand, the gallbladder is diseased so that it cannot concentrate, an obstruction of the common duct results in the collection of clear fluid in the duct system and in the gallbladder If the cystic duct is blocked, the bile in the gallbladder is absorbed and is replaced by the mucous se cretion of the gallbladder mucosa. The gallbladder distends and presents the condition mentioned before, hydrops of the gallbladder (Figure 83)

Stones in the Common Duct

Calculi usually formed in the gallbladder commonly lodge in the com mon duct and may be present in such numbers as to fill the lumen almost solid. They may be several centimeters in diameter or as small as sand, and may be hard or as soft as putty They may pass up into the common hepatic or the left or right hepatic ducts, from these situations down again into the common duct, and thence into the duodenum. The narrowest

part of the common duct is at the papilla of Vater but just above this is the ampulla, and here stones commonly lodge. A ball valve effect may be produced at this point with intermittent attacks of jaundice, chills, and fever Obstruction at the papilla predisposes to pancreatitis and the chronic or acute form of this disease is a common complication. With

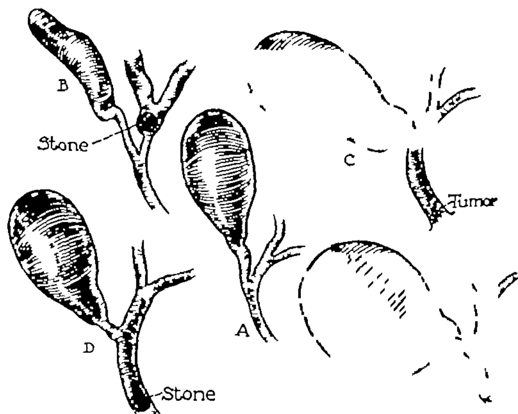


Fig 83. *Diagram of the Usual Effect of Various Types of Obstructions in the Biliary System* A. Normal gallbladder and ducts B Obstruction of the common hepatic duct by a stone Hepatic duct dilated Gallbladder shrunken. C Obstruction of the common bile duct by a tumor Duct and gallbladder dilated D Obstruction of the common bile duct by a stone. Common and hepatic ducts dilated E Obstruction of the cystic duct by a stone Gallbladder dilated.

obstruction of the bile duct, it tends to dilate, and this process extends far up into the finer ducts of the liver Infection of the lymphatics surrounding the duct or intraductal inflammation may produce multiple abscesses of the liver or a long-continued, less severe infection may lead to cirrhosis.

Internal Fistulas

Internal biliary fistula is a communication most commonly between the gallbladder and the duodenum, but it may be between the gallbladder and the stomach, the colon or other part of the bowel Fistulous communication may also take place between the cystic duct and some part of the bowel or between the common duct and the bowel. Fistulas be-

tween the gallbladder or common duct and the gastro-intestinal tract usually heal spontaneously when the obstructive lesion that caused them is removed.

Common Duct Stricture and Atresia

By far the great majority of strictures of the common duct are due to injury to the duct in a previous operation usually a cholecystectomy In all probability in many of these cases the common duct was not properly exposed before the cystic duct was clamped. Not a few strictures, how ever are the result of chronic cholangitis and some are the result of scar tissue at the site of insertion of a T tube or Mayo-Robson drain.

Congenital atresia of the bile duct occurs in extremely rare cases and is a developmental anomaly The condition found may vary from a narrow ing of the common duct to complete atresia of the duct, including the hepatic ducts and is accompanied by enlargement of the liver and jaun dice. The gallbladder may or may not be connected to the common duct and may connect directly to the duodenum or may be an entirely isolated cystic mass. Dilatation of the common duct above the narrowed or absent portions is the rule. This condition is found in the newborn and must be differentiated clinically from other causes of jaundice.

Carcinoma of the Bile Ducts

The most common location of carcinoma of the bile ducts is at the junction of the hepatic, common, and cystic ducts. The next most common site is the papilla of Vater There is dilatation of the ducts above an obstructing lesion, the gallbladder is usually enlarged, and a mass may be palpable at the site of the tumor

Biliary Dyskinesia

This is a disorder of the nervous mechanism that causes the gallbladder to contract against a spasm of the sphincter of Oddi. Removal of the gall bladder may relax the sphincter by breaking a reflex mechanism. When a patient has gallbladder symptoms and at operation the gallbladder appears to be normal, this syndrome should be kept in mind and removal of the gallbladder may be indicated.

TREATMENT

Anomalies of the Gallbladder

In the treatment of anomalies of the gallbladder much must be left to the surgical ingenuity of the operator A mesentery on the gallbladder should make cholecystectomy easier but a gallbladder embedded in the liver and diseased makes the operation extremely difficult. Even the mat ter of finding the gallbladder may necessitate exploratory punctures with

a needle, and after the organ is located, incision of the liver tissue lease it is necessary I have not seen a case of this type but in the ported it was possible to shell out the gallbladder and remove it wi too much hemorrhage. The cut liver surface is brought together by d placed sutures of catgut.

Anomalies of the cystic arteries, on the other hand, are commor should be watched for in every cholecystectomy After the cystic a is clamped, another branch or an accessory artery may be seen, or cystic artery is not found in its usual location above and somewhat b the cystic duct, it should be sought for elsewhere. The common duc right hepatic duct should be guarded during this procedure.

Acute Cholecystitis

The only treatment for gangrenous cholecystitis is cholecystect The ideal treatment for all types of acute cholecystitis is cholecystect but there are exceptions to this rule. When deep jaundice due to ch gitis or hepatitis is present the cystic duct patent, and the patient in condition, cholecystostomy should be performed. In some cases of cholecystitis because of the marked abdominal distention that somet accompanies it, or because adequate relaxation cannot be obtaine because there is too much edema or too many adhesions, it may be nically so difficult to remove the gallbladder that cholecystostomy wi indicated. If the cystic duct is obstructed and the gallbladder is dra a mucous fistula that will never close may result, but here the pati life is the primary consideration in any case, it may be possible to cholecystectomy without much difficulty at a later date

Obstruction of the cystic duct will be indicated by the presence stone in the duct, or by distention of the gallbladder or by the abs of free bile flow when the gallbladder is opened. It is not wise to conc that after a stone has been removed from the cystic duct the duct necessarily remain patent, because even though it may be so at the t inflammatory changes may follow and close it. Because of the spiral v in the cystic duct it may be difficult or impossible to probe throug unless the duct has been dilated previously

Rupture or perforation of an acutely inflamed gallbladder may o sionally occur Perforation may be acute and free with generalized semination of bile and the symptoms of acute shock, or the perfora may take place more slowly with the formation of a localized absc The acute perforation will demand the immediate removal of the g bladder if this can be done before bile peritonitis sets in. If an abs should be found, the appropriate treatment is simple drainage of the scess without any attempt to remove the gallbladder Cholecystecto can be performed at a later operation with much less danger to patient

Chronic Cholecystitis

If the bile ducts are normal the treatment for chronic cholecystitis, as for acute cholecystitis is cholecystectomy It is only in those cases where removal of the gallbladder is so difficult as not to be done with safety or in those patients who are in such poor condition that only the minimum of surgery is possible, that drainage of the gallbladder should be performed. But it must be emphasized that the gallbladder should not be removed until the common duct has been investigated. If obstruction of the common duct is suspected from the history or from the operative findings, the nature of the obstruction must be determined before cholecystectomy is done. If edematous swelling of the pancreas is found, cholecystostomy providing as it does a temporary drainage of the biliary system, may be the better operation. In cases of long-standing obstruction of the common duct with dilatation of the gallbladder caused by chronic pancreatitis or carcinoma of the papilla of Vater the gallbladder is useful in performing an anastomosis to short-circuit the bile into the intestinal tract.

Stones in the Common Duct

When the common duct is seen to be thickened or dilated, or both, this is evidence that obstruction is or has been present, and the common duct should be opened and explored unless one can be sure without doing so that the obstruction is due to a tumor or stricture in the lower portion of the duct. Many times by palpation alone it may be impossible to say whether or not a stone is present in the common duct. The difficulty arises not so often in the portion of the duct that lies in the lesser omentum, but in those parts that lie behind the duodenum in the region of the pancreas. Enlarged lymph nodes in the gastrohepatic omentum may be mistaken for a stone Chronic pancreatitis frequently causes such dense thickening at the head of the pancreas that it may be indistinguishable from stone. When a stone is impacted in the ampulla it may be impossible to say whether one is dealing with a tumor of the ampulla or papilla of Vater or with a stone and only when the duodenum is opened is the diagnosis possible. Most common-duct stones originate in the gallbladder but it is possible to have stones form in the common duct and this probably takes place most often when the common duct is inflamed. The fact that an operation has been performed and stones removed from the common duct, however does not mean that stones found in the common duct at a subsequent operation have necessarily formed there. The most likely explanation is that they were missed at the first operation. Stones in the hepatic duct likewise usually originate in the gallbladder and these may at times be very difficult to remove. When such stones are found and it is suspected that not all of them have been taken out, prolonged

a needle, and after the organ is located, incision of the liver tissue to release it is necessary I have not seen a case of this type but in those reported it was possible to shell out the gallbladder and remove it without too much hemorrhage. The cut liver surface is brought together by deeply placed sutures of catgut.

Anomalies of the cystic arteries, on the other hand, are common and should be watched for in every cholecystectomy After the cystic artery is clamped, another branch or an accessory artery may be seen, or if the cystic artery is not found in its usual location above and somewhat behind the cystic duct, it should be sought for elsewhere. The common duct and right hepatic duct should be guarded during this procedure.

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Obstruction of the cystic duct will be indicated by the presence of a stone in the duct, or by distention of the gallbladder or by the absence of free bile flow when the gallbladder is opened. It is not wise to conclude that after a stone has been removed from the cystic duct the duct will necessarily remain patent, because, even though it may be so at the time inflammatory changes may follow and close it. Because of the spiral valves in the cystic duct it may be difficult or impossible to probe through it unless the duct has been dilated previously

Rupture or perforation of an acutely inflamed gallbladder may occasionally occur Perforation may be acute and free, with generalized dissemination of bile and the symptoms of acute shock, or the perforation may take place more slowly with the formation of a localized abscess. The acute perforation will demand the immediate removal of the gall bladder if this can be done before bile peritonitis sets in. If an abscess should be found, the appropriate treatment is simple drainage of the abscess without any attempt to remove the gallbladder Cholecystectomy can be performed at a later operation with much less danger to the patient.

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drainage by means of a T tube is advisable. It should be kept in mind that in many cases of non functioning gallbladder the common duct may be dilated. This dilatation of the common duct represents an attempt to provide a storage space for the bile and is associated with the dilatation of the parietal sacculi of the duct. Here the history of the presence or absence of jaundice is extremely important. On the other hand, the absence of dilatation of the common duct does not necessarily mean that no stone is present in the duct because it takes some period of time for the duct to dilate. A stone may be present in the duct for a week or more without evident dilatation of the duct and, if the duct is not completely obstructed, little dilatation may be evident after a long period of time. It is also possible for stones to remain in the common duct for years without causing symptoms. Courvoisier stated that in 86 per cent of cases of stone in the common duct, the gallbladder is contracted. Occasionally the common duct and the gallbladder may be dilated to an extreme degree by a stone impacted at the ampulla. This stone is commonly of the single cholesterin type, which is not associated with marked change in the gallbladder wall. Dilatation of the common duct and gallbladder however is usually due to pressure on the outside of the duct, commonly by carcinoma of the head of the pancreas, or to obstruction of the duct by a tumor If there is a history of recent jaundice or recurring attacks of jaundice even though there are no abnormal findings except chronic cholecystitis, it is wise to open and explore the duct. Even when there is no history of jaundice, if the gallbladder contains many stones of such size that they could pass through the cystic duct and the cystic duct is patent the common duct should be explored. Furthermore, if stones are not already present in the common duct, compression of a gallbladder containing many small stones may force some of them out of the gallbladder and into the duct.

Internal Fistula

When a fistula is encountered, the tract should be divided and the opening in the intestine or stomach closed by an inverting suture· if the organ attached is the gallbladder it should be removed If it is the common duct, a catheter or T tube may be placed in the duct at the point where the fistulous communication existed.

Carcinoma of the Bile Ducts

Occasionally an isolated tumor of the common duct may be excised and the duct joined together over a tube or the proximal end implanted into the duodenum, and occasionally carcinoma of the hepatic duct may be removed in the same way Partial removal of an intraductal tumor may be done with a curette, but the result of this operation is merely palliative. If the tumor is below the cystic duct and the duct is patent

cholecystenterostomy may be performed to relieve the jaundice. Carcinoma of the ampulla or papilla of Vater on the other hand, can often be resected along with the duodenum. The head of the pancreas is frequently attached to the duodenum by the growth of the tumor and is included in the resection. The technique of this operation is described in the chapter on The Pancreas. If metastasis is not present it should be done, preferably in two stages.

Stricture and Atresia of the Bile Ducts

In a high percentage of cases, postoperative stricture of the common duct occurs in the first portion and just below or at the level of the cystic duct. A very simple procedure is to incise the duct longitudinally at the region of the stricture, insert a T tube and leave it in for several months but the results of this procedure are very unsatisfactory because the stricture usually recurs The best procedure is to excise the stricture and perform an end to-end anastomosis.

If the stricture is located far down in the common duct, the duct may be sectioned above it and choledochoduodenostomy performed, but it is always best to utilize the lower end of the duct if possible. The duodenum may be mobilized and the pancreatic portion of the duct freed enough to make an anastomosis at this point if necessary In some cases when the dilated duct is large and mobile, the side of the duct can be anastomosed to the side of the duodenum by the method used in gastroenterostomy but this is not as satisfactory an operation. For stricture of the upper end of the common duct or the common hepatic duct, the hepatic duct is cut above the stricture and anastomosed to the duodenum (hepaticoduodenostomy) or jejunum (hepaticojejunostomy)

The foregoing operations are used in the treatment of atresia of the common duct or the lower end of the common hepatic duct, but if as so often happens in congenital malformations, no extrahepatic ducts can be found, a catheter is sutured to or in close proximity to any dilated duct found by aspirating near the hilum of the liver the catheter is inserted into the duodenum through a small incision, and the duodenum is brought up and sutured in place against the hilum of the liver (internal biliary fistula)

If the gallbladder is present and the cystic duct is patent, the gallbladder may be anastomosed to the stomach or duodenum, preferably the latter but this operation may be followed by an ascending infection of the liver If none of the above operations can be done, an external biliary fistula may be established and later the fistulous tract anastomosed to the duodenum, but biliary obstruction is common after this operation and it is to be avoided if possible.

In occasional cases particularly when the stenosis is located in the pancreatic part of the duct and is due to past inflammation, the simple

passage of a dilator through the ampulla is sufficient to relieve the obstruction. Even in these cases prolonged drainage by means of a T tube is advisable. This is true also when the duct is obstructed by inflammatory swelling of the head of the pancreas.

TECHNIQUE

Exposure of the Common Duct

After the duct has been examined as thoroughly as possible by palpation it should be exposed so that its size can be determined. No attempt should be made to do this while keeping one finger in the epiploic foramen but the hepaticoduodenal ligament should be put under tension by the hand of the assistant, as described above, and dissection should be begun at the point where the cystic duct enters the common duct. In most cases it is not necessary to expose the common duct at any other point than this unless some operative procedure must be done. In that case the peritoneum is cleared from the duct along the margin of the hepaticoduodenal ligament by extending the incision begun in the region of the cystic duct. Exposure of the duct at the cystic-duct juncture is essential before the gallbladder is removed and is combined with simultaneous exposure of the cystic duct. The dissection is done by means of Mayo scissors and, if reasonable care is used in handling the common duct, there is little likelihood of damage to the portal vein or hepatic artery If the portal vein should inadvertently be injured, the gloved finger should be applied to the vein and held there for a short period of time and the bleeding may cease. Bleeding from the portal vein may be temporarily controlled by grasping the hepaticoduodenal ligament between the thumb and index finger and making pressure. This maneuver also stops bleeding from the hepatic and cystic arteries, and does not damage the liver if continued for only a few minutes. If necessary the portal vein may be further exposed and sutured with very fine silk on a curved needle but this of course should not be resorted to unless other measures fail.

If the common duct is found to be normal in size and no stones can be felt in it, and the head of the pancreas seems to be normal then attention may be directed back to the gallbladder and the indicated procedure, either cholecystectomy or cholecystostomy should be performed.

Cholecystectomy

The cystic duct does not leave the gallbladder like the stem of a pear but, because of angulation of the duct, it appears to come off a little above and to the inner side, and a pocket is thus formed known as Hartman's pouch or the pelvis of the gallbladder Unless the organ is grasped with forceps and pulled up with sufficient tension to straighten out this pouch,

the cystic duct may not be plainly seen. The most satisfactory procedure is to apply one pair of forceps to the fundus of the gallbladder pulling it upward, and then to apply a second pair of forceps in the region of Hart



FIG 84 *Cholecystectomy* The gallbladder is pulled up by forceps to place the cystic duct under tension.

man s pouch (Figures 84 and 85) Frequently the gallbladder may be so tense that it is almost impossible to grasp it with forceps. This is true very commonly when there is a stone impacted in the cystic duct. By inserting a large-caliber needle into the gallbladder the contents may be aspirated and the situation materially improved. When the needle is withdrawn, a



FIG 85 *Cholecystectomy* The ducts are palpated.

clamp can be applied to the puncture hole. When the contents of the gallbladder have been aspirated, a stone impacted in the cystic duct, which previously could not be felt, may be quite evident. Usually it can be milked back into the gallbladder by pressing on the duct with the fingers. If this maneuver is not successful it is advisable to open the gallbladder empty the contents and insert a scoop around the stone. On

rare occasions it may be necessary to incise the cystic duct and remove the stone through the incision but in many cases the cystic duct is long enough so that it may be clamped below an impacted stone.

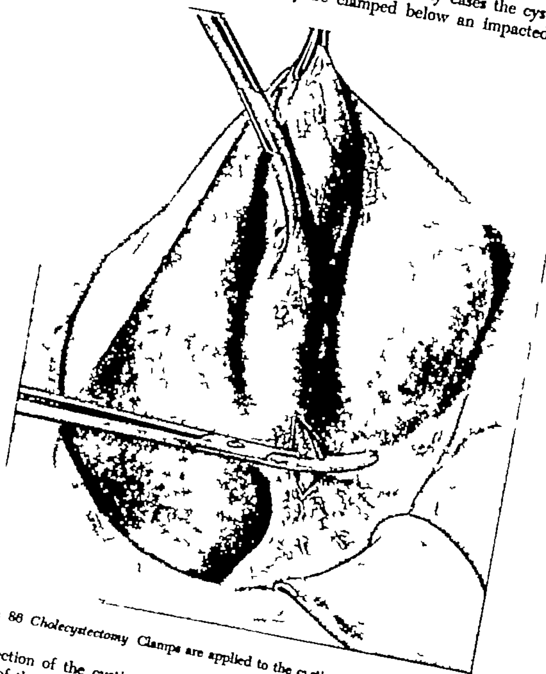


FIG 88 *Cholecystectomy* Clamps are applied to the cystic artery and cystic duct.

Dissection of the cystic duct is actually partly completed in the exposure of the common duct It is most safely begun in the angle between the cystic and common duct on the medial side of the cystic duct. After proper exposure of the cystic duct and the common duct at its juncture a curved clamp is applied to the cystic duct and artery (Figure 88) The clamp should be directed toward the gallbladder and not toward the

common or hepatic ducts. As long as the common duct is kept in view the clamp can be applied with confidence that the duct will not be injured, but unless care is taken not to make too much tension on the gall-



FIG. 87 *Cholecystectomy* Cystic duct and artery being divided between clamps.

bladder it is possible to pull the common duct up so that it is almost indistinguishable from the cystic duct, and when the clamp is applied it may include the angulated common duct. For maximum safety it is best to apply two more clamps to the cystic duct and artery and make the incision between the distal two (Figure 87) since most cystic ducts are long enough to accommodate three medium sized forceps. The duct and artery may then be tied and, as the first clamp is removed, the knot is tightened

and the ligature will fall into the groove made by the clamp A second tie can be made before the removal of the second clamp. The cystic duct may be clamped separately from the cystic artery—I do this a good share

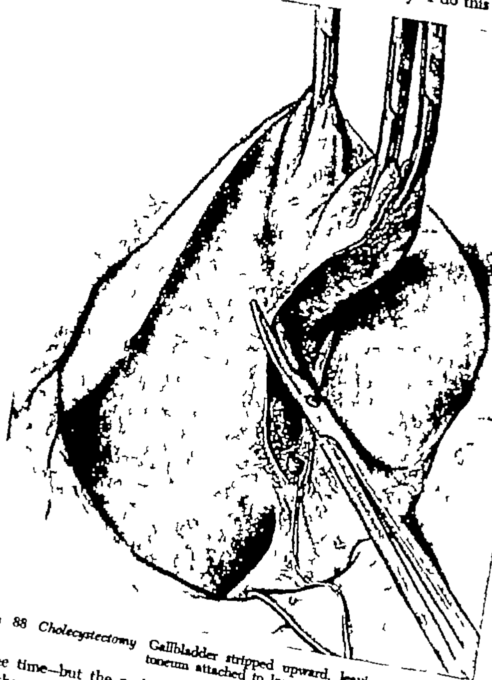


Fig 88 *Cholecystectomy* Gallbladder stripped upward, leaving fold of peritoneum attached to liver

of the time—but the main advantage from this maneuver is to insure that the cystic duct is properly identified. By this method, after the duct has been explored, the hemostats are applied to it with one blade of each passing through Calot s triangle between the cystic vessels and the duct. After the duct has been cut and tied, the cystic artery is dealt with.

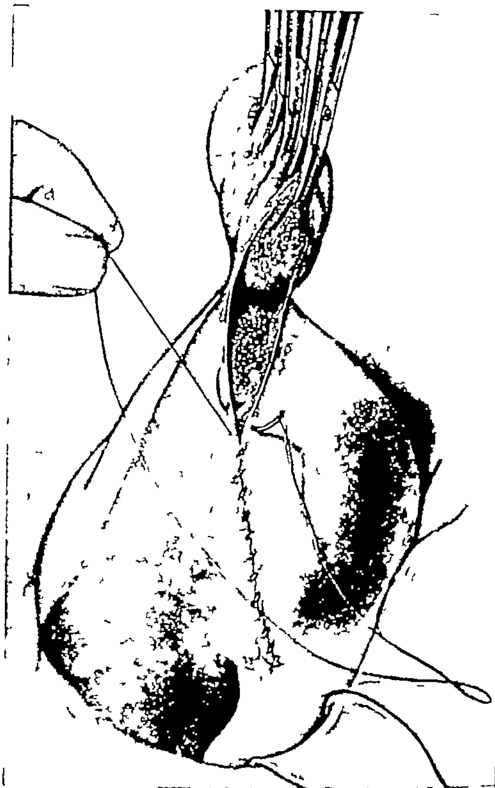


FIG. 89 *Cholecystectomy* Peritoneum of gallbladder bed being sutured.

Hemorrhage from the cystic artery can be controlled by squeezing the hepaticoduodenal ligament. Forceps should never be inserted blindly into a pool of blood in an attempt to find the bleeding vessel. If the thumb and finger are inserted into the blood, the source of the bleeding can sometimes be felt if the vessel is of any size and the bleeding point may be grasped between the thumb and finger and held while the field is cleared and preparations are made to clamp the vessel. When the cystic artery is held in a clamp that seems to be insecure and it appears danger ous to attempt to ligate the vessel, the clamp may be left in place and removed only after forty-eight hours. Before it is removed, the clamp should be unlocked and left in place for several hours before an attempt is made to pull it out. This enables the tissues held in the clamp to become loose gradually so that when tension is made on the clamp the tissues will not be torn off.

As the gallbladder is separated from the liver care should be used to save a cuff of peritoneum attached to the liver so that it can be sutured together (Figure 88) The avoidance of a raw oozing surface is impor tant to convalescence, particularly in the jaundiced patient, and reduces the possibility of adhesions. If no peritoneal cuff can be saved and there is considerable bleeding, the liver may be sutured together over the gall bladder fossa by the use of a curved blunt needle and catgut. If the gall bladder is left partly attached to the liver until the suturing of the liver bed is attended to it facilitates exposure (Figure 89)

Not infrequently it may be easier to remove the gallbladder from without inward, although this method is usually associated with considerably more hemorrhage, it can be done with reasonable safety and not much difficulty

Cholecystostomy

The gallbladder is grasped by two Allis forceps and walled off with moist packs. After the contents have been aspirated by means of a trocar or large-caliber needle and syringe the gallbladder is opened (Figure 90) and the stones, if any are removed. A tube the size of a lead pencil is then inserted into the gallbladder and held in place by a pursestring suture (Figure 91) It is wise to hold the tube in place by passing the catgut around the tube and tying it, or by running the needle with the catgut through the wall of the tube It is not necessary to bring the tube through the omentum before bringing it out through the abdominal wall.

After cholecystostomy or cholecystectomy one or two Penrose drains should be inserted down to Morrison s pouch.

Choledochostomy

The most frequent occasion for choledochostomy is presented by the presence of stone in the common duct. Removal of these stones if care-

fully done is always a time-consuming procedure A conscientious surgeon, even after he has become morally certain that all of the stones have been removed from the common and hepatic ducts, will continue to probe these structures again and again. The mere passage of a scoop down the common duct into the duodenum without feeling any stones or finding

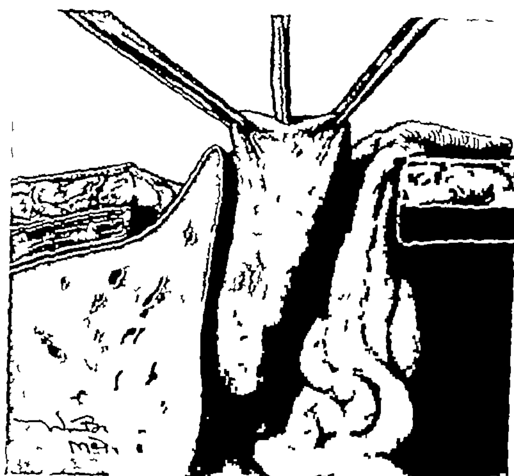


Fig. 90 *Cholecystostomy* The gallbladder is held by Allis forceps while an opening is made in it.

any obstruction may mean little. Even after the scoop has been passed into the duodenum and up into the hepatic duct time after time, it is surprising how frequently a continued search will bring out another stone. On the other hand, too much probing in itself is not without some danger because of the possibility of injury to the lining of the common duct and subsequent stricture Probing must be done in the gentlest possible manner and, since the ideal place from which to remove a common-duct stone is in the first or supraduodenal portion, an attempt should always be made to get the stone into that portion of the duct. If the stone is already palpable in that region, the duct may be opened over the stone If not, a good portion of the duct should be freed from the tissues of the hepaticoduodenal ligament and the duct opened a short distance below the en-

trance of the cystic duct. Before opening the common duct, it is a safe procedure to insert a hypodermic needle and be sure that the content of the structure that it is proposed to open is bile and not blood. The duct having been lifted up by two Allis forceps a longitudinal incision is made into it and a probe inserted (Figure 92)

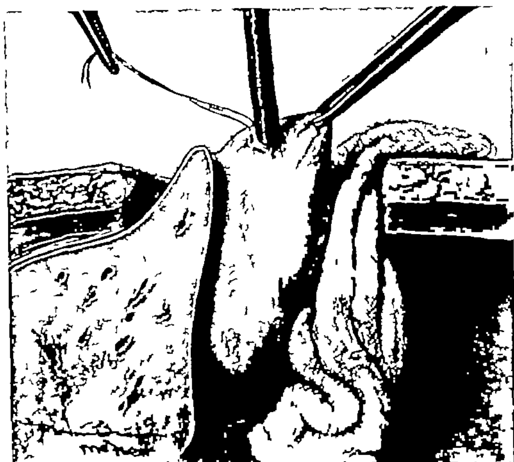


FIG. 91. *Cholecystostomy* A tube has been placed in the gallbladder and a pursestring suture has been inserted. One bite of the suture passes through the wall of the tube.

If obstruction is met or a stone is felt, the probe is removed and a scoop is inserted. In many cases where the stone can be felt in the second portion of the duct, it may be pressed back into the first portion, where it can be easily removed, but if the duct is sufficiently dilated and the fore going procedure does not suffice, the finger may be inserted into the duct, and by making pressure on the duodenum and the head of the pancreas the stone may be pressed upward as the finger is removed. In the event that a stone is present in the retroduodenal portion of the duct and it cannot be forced back into the supraduodenal portion, a retroduodenal choledochostomy may be performed. This approach to the retroduodenal portion of the duct is made by first incising the peritoneum about an inch

to the right of the duodenum and then stripping the peritoneum ba wards until the duodenum is reached. The duodenum can then be rota to the left and the common duct lying behind it exposed (Figure 9



FIG. 92 *Choledochostomy* The common duct has been exposed in the gastrohepatic omentum A longitudinal incision has been made in the duct and is being held open by Allis forceps while a scoop is introduced

Part of the pancreatic portion of the duct may be covered by or lie in the substance of the pancreas and it may be necessary to cut or separate the lobes of the pancreas to get at it. Occasionally a stone impacted at the ampulla may be impossible to remove through the duct. It is a simple procedure to open the duodenum (Figure 94) in the descending portion

and if necessary incise the ampulla a short distance, making the stone readily removable Transduodenal choledochostomy the incision of the anterior wall of the duodenum and the mucous membrane of the duodenum down to the duct, is now rarely performed.

After the stones have apparently been completely removed from the duct, a catheter attached to a syringe is introduced and water is injected.

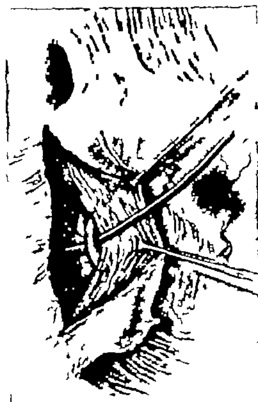


FIG. 93. *Exposure of Retroduodenal Portion of Common Duct*



FIG. 94. *Transduodenal Excision of Tumor of Papilla of Vater*

This may wash-out more stones and the patency of the duct is demonstrated by distention of the duodenum. If the duct is clear the catheter is removed, if not, more probing and scooping must be done. The injection of radiopaque material into the common duct, followed by an X ray of the region, has great value in determining the presence or absence of obstruction, but the radiopaque material may pass into the duodenum even though stones are present in the common duct, and the interpretation of X ray appearance of stone in the common duct as shown by this method is not easy Following exploration of the common duct a T tube or a catheter is inserted into the common duct, the latter pointing in the direction of the liver and the opening in the duct is closed about the tube with fine catgut sutures When because of inflammation of the pancreas or severe liver damage, it seems advisable to have more prolonged drainage than the Mayo-Robson tube provides the T tube must be used (Fig

ure 95) and can be left in for several months if desired. If before the T tube is inserted a V is cut in it just opposite the origin of the upright arm, the tube will be easier to put in and remove.

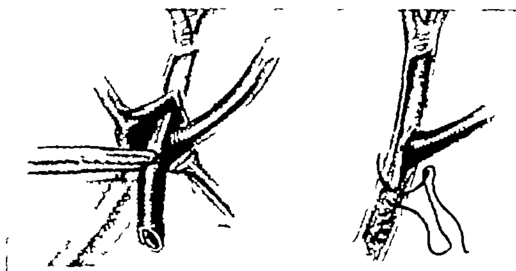


FIG. 95 *Insertion of T Tube in Common Duct.*

Before the operation is concluded one should be sure that there has been no accidental injury to the common duct. If there is unexplained leakage of bile the duct should be examined and if an opening is found or if the duct has been cut, it should be immediately sutured with fine cat gut.

End-to-End Anastomosis of the Common Bile Duct

The anastomosis may be made over a section of rubber tubing which may be one arm of a T tube inserted through an incision a short distance above or below the point of anastomosis. Interrupted sutures of fine cat gut or silk are used to approximate the entire circumference of one end of the duct to the other

Cattell has recently pointed out that for strictures far down in the common duct, end to-end anastomosis can be performed by mobilizing the pancreatic portion of the duct. The duodenum is turned medially after cutting the peritoneum along its lateral border and the posterior surface of the head of the pancreas is exposed. The anterior branch of the superior duodenal artery is cut and ligated and the pancreatic portion of the duct dissected out by splitting the pancreatic tissue. The left side of the duct near the ampulla is not freed, because of the possibility of injuring the pancreatic duct. After this procedure the common duct can usually be anastomosed over a tube to the hepatic duct near the liver The tube is first anchored in the hepatic duct and then introduced into the mobilized common duct and end to-end suture of the ducts is performed.

Instead of a rubber tube, one of Vitallium may be used. Vitallium tubes are made with a flange on one side, which keeps them from passing into the duodenum before healing has taken place thus making stenosis less likely They may become plugged or displaced, but on the whole are more satisfactory than rubber

If there will apparently be no tension on the suture line and a satisfactory anastomosis is possible without difficulty it is better to dispense with a tube entirely since any foreign body in the duct predisposes somewhat to stricture. Two guy sutures are used to hold the duct ends while the sutures are put in.

Hepaticoduodenostomy and Hepaticojejunostomy

Anastomosis of the common hepatic duct to the duodenum is a valuable procedure when there is a stricture or atresia of the common duct. The first and greatest problem in these cases is oftentimes the locating of the hepatic duct above the point of stricture or atresia. When the gallbladder is present, the cystic duct should be followed down to its junction with the common duct and, by careful dissection in the gastrohepatic ligament and upward toward the liver the dilated stump of the patent duct should be identifiable. When adhesions are present from a previous operation and when the gallbladder is absent, as it so often is, the operation is much more difficult. The edge of the liver should be located and followed down toward the hilum, and, with painstaking dissection and frequent exploratory aspirations, bile should be encountered. With the duct located by the needle, it can be approached with more assurance In infants there may be no identifiable ducts outside the liver and, unless a source of free bile flow can be located by inserting a needle into the liver near the hilum, the operation must be abandoned. If however a dilated duct is found by the needle an incision is made down to it through the liver substance If the right and left hepatic ducts are located, they are separately anastomosed to the duodenum by the method described below for the common hepatic duct.

The common hepatic duct having been located, the end of it is opened and a short piece of rubber tube is introduced. This is anchored in place by a single catgut suture between the catheter and the wall of the duct. Two guy sutures are placed on the end of the duct, and similar guy sutures are inserted in the nearest part of the duodenum. The duodenum may be mobilized considerably by cutting the peritoneum along its lateral edge, and must be brought into contact with the end of the duct without tension. If this cannot be done hepaticojejunostomy must be performed. A small stab wound is made in the wall of the duodenum between the holding sutures. The catheter in the duct is introduced into the duodenum and a series of interrupted sutures of fine catgut or silk are placed between the duct and the duodenum. These sutures should pass

through all layers of both structures, but the mucosae must be accurately approximated. Each suture is held with a hemostat and not tied until all have been inserted.

Hepaticojejunostomy can often be performed when the duodenum cannot be approximated to the hilum of the liver The procedure is essentially the same as that just described. A loop of jejunum is brought in front of the transverse colon and the anastomosis is made about 20 cm. from the ligament of Treitz. Entero-enterostomy should be performed between the ascending and descending loops of jejunum, so that food from the stomach does not have to go up to the region of the hilum of the liver before passing down the intestinal tract.

Formation of Internal Biliary Fistula

A source of free bile drainage from a dilated duct having been located at the hilum of the liver a catheter is sutured as close to it as possible. The catheter is pushed up into the liver substance a short distance if necessary and is sutured to any adjacent structure to hold it in place. A small opening is made in the duodenum to admit the catheter, and the duodenum is approximated to the liver mobilizing it as much as necessary Sutures are inserted between the liver edge and the duodenum and between the duodenum and the gastrohepatic ligament to support the bowel in close approximation to the liver If in this operation the duodenum cannot be approximated to the liver the jejunum should be used.

Transplantation of Biliary Fistula

By dissection and exploration with a needle, a source of free bile flow is located at the hilum of the liver the end of a catheter is sutured in place as close to this point as possible, wrapped with omentum, and the end brought out through a stab wound in the abdominal wall The catheter will become loose in about two weeks but bile drainage should continue. After several months when the tract is firmly established, the second stage of the operation is performed. An incision is made around the fistulous opening and continued upward and downward to afford free access to the abdominal cavity The fistulous tract is cored out with scissors, with no attempt to approach it closely Plenty of abdominal wall and omentum are left around it, and the dissection is continued inward until the fistula can be approximated to the duodenum by a fairly direct course. Excess length of the tract is cut off, a short incision is made in the duodenum, and the fistulous tract is inserted into the lumen. The opening in the duodenal wall is sutured to the fistula throughout its circumference.

Choledochoduodenostomy

This is described under transplantation of the bile duct in the chapter on The Pancreas.

Cholecystogastrostomy and Cholecystenterostomy

These operations are also described in the chapter on The Pancreas.

POSTOPERATIVE CARE

Fluids are given by mouth when nausea has subsided, but the fluid intake, glucose, and protein should be kept up by intravenous injections. Vitamin K therapy should be continued as long as there is jaundice or external loss of bile, and bile salts should be given at the same time. Breathing exercises should be given frequently the first day to help in preventing pulmonary congestion or atelectasis.

A soft rubber drain left in the gallbladder region should be removed in 24 hours A catheter in the common duct or a cholecystostomy tube is removed when it becomes loose usually at about the twelfth day The length of time a T tube is left in depends upon the reason for its insertion, and clinical judgment must be used in its removal. Before the tube is taken out, it should be clamped off for several days to be sure that bile appears in the stools and that the patient has no symptoms of biliary obstruction. A cholangiogram may be useful if the presence of obstruction or a stone is suspected.

CHAPTER XIV

The Pancreas

The Pancreas

The pancreas with its internal and external secretions and its location in close proximity to the common bile duct may give rise to some of the most dramatic and interesting of all diseases The treatment of most of these conditions is surgical, however, only in recent years has anything like encouraging progress been made in the extensive operative procedure that is necessary in many cases.

PREOPERATIVE TREATMENT

In conditions such as acute pancreatitis or wounds of the pancreas, there may be a grave disturbance in the electrolyte and fluid balance which should be corrected by the intravenous administration of normal saline solution. In these conditions also determinations should be made of the serum amylase, since a rise in this value may indicate progressive destruction of the pancreas The normal blood amylase is usually not over 180 units. In the presence of latent jaundice an icterus index is helpful, and if hypoprothrombinemia is present, vitamin K should be given. Even when operation must be performed immediately the intravenous injection of 2 cc. of the water soluble synthetic compound and a transfusion of fresh plasma or fresh blood may reduce the danger of hemorrhage Vitamin K therapy is discussed in more detail in the chapter on The Gallbladder When a patient with hypoglycemia, such as may be associated with adenoma of the pancreas is to be operated on, 1000 cc. of 5 per cent glucose in normal saline should be given intravenously before operation. After operation the opposite condition, hyperglycemia, may be present and require insulin.

INCISION

The pancreas may be approached through a right paramedian, right rectus, or upper midline incision but in broad or obese individuals a transverse incision across the upper abdomen gives the best exposure.

EXPLORATION

As the peritoneal cavity is opened, the character and amount of the peritoneal fluid should be noted. The presence of an abnormally large amount will indicate the presence of peritoneal irritation, and the presence of fibrinous flecks in the fluid will indicate that the irritation is inflammatory in character A wide-bladed retractor should be inserted in the right upper portion of the incision and pulled laterally by the second assistant. The surgeon s left hand is now inserted under the margin of the liver and the gallbladder palpated. If the patient is jaundiced, the con dition may be due to obstruction within or without the duct. Since stones in the common duct are the most common cause of intraductal obstruc tion stones should be sought for in the gallbladder the first portion of the common duct as it passes through the gastrohepatic omentum, and the para and post-duodenal portions of the duct. Any fat that comes into the field of vision should be carefully inspected for the presence of fat necrosis, which will appear as pinhead sized white flecks. If these are present they are irrefutable evidence of pancreatic necrosis, or at least of the escape of pancreatic juice into the peritoneal cavity The left index finger is inserted into the foramen of Winslow Occasionally when this is done a large amount of fluid will pour out of the lesser sac. This is an indication of acute inflammatory disease of the pancreas, or perforating ulcer on the posterior surface of the stomach. The left thumb is now approximated toward the index finger and the head of the pancreas is palpated. One must differentiate a firm enlargement at the head of the pancreas from a stone impacted in the ampulla of Vater or a tumor of the papilla of Vater The body of the pancreas is now palpated through the gastrocolic omentum by raising the stomach somewhat out of its position. Any sign of enlargement or nodules should be carefully sought for The anterior surface of the stomach and duodenum should be inspected and felt, looking for scars or induration which will be evidence of ulcer If a mass is found in the stomach suggestive of carcinoma, attention should be directed to the gastrohepatic omentum to determine whether there are enlarged glands in this location that may be obstructing the common duct, or whether there is extension into the fat of the lesser omentum which has constricted the common duct. Carcinoma of the stomach that has progressed to the point of obstructing the common duct in the gas trohepatic omentum is inoperable but one may consider the advisability of doing an operation to short-circuit the bile from the gallbladder to the duodenum. As a rule, however a patient with this condition is such a poor risk and the life expectancy is so short that the operation is rarely indicated. If the posterior surface of the stomach appears thickened and the presence of an ulcer there is suspected, an incision should be made through the gastrohepatic omentum, the lesser curvature of the stomach

pulled down, and this portion of the stomach can be inspected. If a perforated ulcer is found it should be closed and drainage instituted from the lesser sac. This may be done by bringing a Penrose drain out through the rent in the gastrohepatic omentum and closing this structure rather loosely around the tube. If a lesion of the posterior wall of the duodenum is suspected, an incision may be made in the anterior wall of the duodenum by which the first and second portions of the duodenum may be inspected. If a small tumor of the papilla of Vater is found, this may be excised and its base cauterized. If the tumor is large it may be necessary to remove the second portion of the duodenum and perform a cholecystojejunostomy as described under carcinoma of the head of the pancreas (page 291) Before any radical operation is begun, in fact as soon as it has been ascertained that no acute inflammatory condition is present which would be spread around the abdomen, a general abdominal exploration is conducted. The liver is examined for the presence of nodules that may mean metastasis. The size of the spleen is determined and the hand then passes down to the pelvis to examine the pelvic organs, the colon and the appendix. If the peritoneal fluid indicates acute inflammation in the peritoneal cavity and nothing is found in the upper abdomen to explain it, one should approach the pelvic organs and appendix with great care so as not to break up adhesions and spread infection. The right rectus incision may be extended downward to remove an acutely inflamed appendix, but if inflammation of the pelvic organs is found and surgical attention is necessary the upper abdominal incision should be closed and another incision made in the low midline. The lower abdomen having been investigated, returning now to the upper abdomen, one should expose and determine the size of the common duct. Obstructive jaundice if produced by tumor of the head of the pancreas, is usually associated not only with enlargement of the common duct but also with dilatation of the gallbladder In those cases where jaundice is caused by inflammatory changes in the pancreas there may be enlargement of the common duct, but the gallbladder is usually not increased in size. If the nature of the common-duct obstruction cannot be determined, the duct should be opened and a scoop passed downward into the duodenum with a search for stones and an attempt to find the point of obstruction.

LESIONS OF THE PANCREAS

Acute Pancreatitis

This condition, which might more properly be termed acute pancreatic necrosis, may vary from a simple edema of the pancreas in the early stages to a hemorrhagic, gangrenous, or suppurative form within *a few hours. The gland is diffusely enlarged,* although in some cases the

change may be confined at first to the head. It is usually harder than normal, but, as extensive necrosis proceeds the organ may become softened and sloughing Associated with the process in the pancreas itself there may be an out pouring of fluid into the lesser sac, and nearly always, particularly in the region of the pancreas itself will be seen the characteristic white spots of fat necrosis. These vary from pinhead size to a centimeter or more in diameter When the process has been going on for several days these gravish-white spots of calcium soap may be seen spotting the greater omentum, the mesentery and in fact any place in the peritoneal cavity where fat cells are present. There may be a slight degree of jaundice and stones are often present in the gallbladder and occasionally in the common duct.

Chronic Pancreatitis

This is a progressive fibrosis of the pancreatic gland, which makes it feel much firmer than normal. In some cases the induration is so pronounced that it may be necessary to excise a small piece of the gland for microscopic examination to rule out carcinoma. There is probably not a great deal of enlargement of the pancreas unless there is an associated chronic edema, but the unusually firm consistency particularly of the head of the gland, often leads the surgeon to describe the organ as being much enlarged. The disease is commonly associated with chronic cholecystitis and cholelithiasis, and there is not infrequently dilatation of the common duct and a certain degree of jaundice.

Calcification of the Pancreas

Diffuse irregular areas of calcification may occur in the pancreas, and a moderate number of cases have been reported. About half the cases are associated with cholelithiasis, and the condition is believed by some to follow repeated attacks of acute pancreatitis. There may be large calcified plaques in the substance of the gland and there is likely to be associated fibrosis and multiple small cysts, the latter averaging about 1 cm in diameter The patient may have severe epigastric pain and there may be symptoms of pancreatic insufficiency such as bulky and fatty stools.

Pancreatic Calculus

Stones, usually multiple are occasionally found in any part of the main or accessory ducts of the pancreas but they are more common near the head. They may by obstructing the pancreatic ducts, cause a chronic or even acute pancreatitis, which involves the entire gland. When a patient has symptoms suggestive of common-duct stone and no stones are found in the common duct, the pancreas should be carefully palpated and a pancreatic stone may be found.

Rupture and Wounds of the Pancreas

Because of the deep-lying position of the pancreas it is rarely wounded by external violence unless there are severe injuries to other organs. The presence of a mass in the region of the pancreas, or blood in the lesser sac, should lead to a close inspection of the organ by the usual route of exposure. The gland may be torn completely across with profuse hemorrhage, and leakage of pancreatic juice with fat necrosis may be widely evident.

Benign Tumors

These are rather rare and usually are fibroadenomata fibromata, cystadenomata or adenomata. Since the adenomata may in certain instances, produce insulin and hypoglycemia, they are of considerable interest to the surgeon. *They are usually located in the body or tail of the pancreas* and as a rule are so small that they will not be discovered unless the pancreas is exposed for close inspection. They stand out only a slight degree above the level of the pancreas but may be detected by their purplish color As they are frequently multiple, if one is found others should be searched for In order to examine the posterior surface of the body and tail of the pancreas the peritoneum along its lower border is cut and the gland is lifted up The posterior surface of the head is examined by incising the peritoneum along the side of the duodenum and rolling the duodenum toward the midline By careful palpation the tumors can be detected as rounded nodules somewhat firmer than the gland substance.

Cysts

A true cystic tumor or cystadenoma of the pancreas is a rare lesion and seldom reaches such size as to demand surgical intervention. This is true also of the retention cysts, which are sometimes seen and are thought to be due to intermittent blockage of the pancreatic duct Both types contain clear mucoid secretion. The large so-called pancreatic cysts according to Boyd,[1] are not true tumors and in most cases do not arise from the pancreas at all, but from the immediate neighborhood of the pancreas. Others believe that they may arise from the pancreas after trauma or as a result of encapsulation of an area of spontaneous hemorrhage. Whatever their origin they may reach enormous size fill up the lesser sac and project forward, pushing the stomach anteriorly or more frequently they present between the stomach and liver or between the stomach and colon. They usually contain brownish fluid, in which tests may reveal the presence of pancreatic ferment. The main mass of the cyst usually presents in the midline but there is some tendency for the prominent part to be

1 Boyd, W *Surgical Pathology* Fifth Edition, p 349 Philadelphia, 1942.

toward the left. It is sometimes very difficult to differentiate such a cyst from one that originates in a retroperitoneal sarcoma, but usually the lat ter will show a considerable amount of firm fixed tumor at its base

Malignant Tumors

Adenocarcinoma of the pancreas is a rather common disease and, with extremely rare exceptions, it is the only malignant tumor of the pancreas. It occurs more commonly in the head of the gland, and here, because of the close proximity of the pancreas to the common bile duct, it produces biliary obstruction with jaundice, and dilatation of the common bile duct and commonly of the gallbladder Because of the early onset of jaundice when the tumor is in the head, these cases usually come to operation before they have reached any considerable size. When located in the neck, body or tail of the gland, the symptoms are not striking and the only operative findings will be a hard mass in the region with or without metastasis or extension to the neighboring glands. With growth and extension of carcinoma of the pancreas, the gland becomes densely fixed to the posterior body wall and often to the posterior wall of the stomach, and the regional glands show early involvement.

TREATMENT

Acute Pancreatitis

The patient with acute pancreatic necrosis, which has progressed to the stage of necrosis or suppuration and requires surgery is extremely sick and as soon as the diagnosis has been confirmed at operation no fur ther exploration of the abdominal cavity should be done All that surgery has to offer in the treatment of this condition is drainage of the pancreas or the region of the pancreas, and drainage of the bile to the outside. It is best to cut widely through the gastrocolic ligament and lift the stomach up or open through the gastrohepatic ligament and pull the stomach down in order to obtain a direct view of the pancreas The peritoneum covering the pancreas is incised and, when the disease has progressed to a suppurative or sloughing stage, it may be possible to remove some necrotic pieces of the gland that are held loosely in place. In doing so how ever one must remember the extreme vascularity of the organ and use care, particularly not to break any of the thin walled veins. One or two Penrose drains are introduced to the region of the pancreas and brought out either above or below the stomach, according to which gives the more direct route to the incision. Because of the probability that the disease may have been initiated by the passage of bile up the pancreatic duct, it is considered wise to drain the gallbladder Accordingly a chole cystostomy is performed with the greatest expedition.

Chronic Pancreatitis

In these cases one must deal with two factors first the cause of the disease, and second, the disease itself The common duct should be opened and carefully probed and explored to rule out the presence of common-duct stone. A badly diseased gallbladder should then be removed. The only treatment available for the pancreatitis is prolonged drainage of bile, and this is best accomplished by the insertion of a T tube in the common duct. This tube can be left in for several months and removed only when it is found after trial clamping of the tube that the bile is no longer obstructed. One may likewise demonstrate the patency of the common duct by the injection of radiopaque material into the tube. If the gallbladder is not too badly diseased it is probably wiser not to remove it, but to insert a drain in the gallbladder as well as the T tube in the common duct. Then in the event that the prolonged drainage of the bile has not cured the pancreatitis, at a later operation the gallbladder can be anastomosed to the duodenum to relieve the obstructive jaundice

Calcification of the Pancreas

If there is intractable pain associated with calcification of the pancreas, pancreatectomy may be done using the same technique as in the operation for carcinoma. Partial pancreatectomy has also been performed, with good results reported, and recently sympathectomy has been advised.

Pancreatic Calculi

Palpation of the second part of the duodenum may reveal an area of induration near or above the region of the papilla of Vater If a probe inserted through the common duct does not reveal any obstruction or stone, the peritoneum along the outer surface of the duodenum is incised and the duodenum is rolled medially to give access to the point of entrance of the main pancreatic duct of Wirsung into the ampulla of Vater If a stone can then be palpated it may be cut down upon and removed, and a few interrupted sutures placed in the pancreatic tissue. If a stone should be felt in the neck body or tail of the pancreas, the organ may be approached as usual through the gastrohepatic or gastrocolic omentum. The stone may be cut down on, and the duct if dilated may be probed and scoops passed into it. The duct should be sutured with interrupted sutures of fine silk, and the substance of the gland and its capsule with mattress stitches One or two Penrose drains should be inserted to the region. The opening made in the omentum should be sutured so as to leave only the necessary room for the drain.

Injuries of the Pancreas

Any bleeding vessels that are observed should be caught and tied, and the pancreas itself sutured as carefully as possible When a portion of the organ is torn partly off it may be advisable to remove the distal portion, ligating the stump of the duct of the proximal portion with silk, and in vaginating it into the substance of the gland. If the splenic artery is torn, as it may be in severe injuries to the pancreas, splenectomy should be done. On occasions a portion of the pancreas may be deliberately removed along with a carcinoma or penetrating ulcer of the stomach, and the tail of the pancreas may be removed inadvertently in performing a splenectomy or nephrectomy In both cases the severed duct, when it can be identified, should be ligated individually and the stump closed by through-and through mattress sutures of silk and peritonealized as well as possible. In such cases drainage should always be instituted. Not infrequently following any incision or injury of the pancreatic tissue, pan creatic fistula occurs. Because of the enzymes present in the secretion, marked excoriation of the skin occurs and the treatment is very trouble some. Fortunately the fistula usually heals spontaneously in a few weeks.

Benign Tumors

Since these tumors are small and encapsulated, it is only necessary to cut through the capsule of the gland and sometimes a little gland tissue, ligate any small vessels that enter into the tumor and shell them out. The capsule of the gland is closed with a few interrupted sutures and, if there has been leakage of pancreatic juice drainage is instituted to the lesser sac. If no tumor can be found and the symptoms definitely indicate the presence of one, removal of the tail and the portion of the body to the left of the superior mesenteric vessels may be justified.

Cysts

No treatment is necessary for the usual retention cysts of the pancreas. If a cystadenoma should be encountered, one is justified in removing it even if it is small. The capsule of the gland is incised blood vessels are ligated, and by progressive blunt and sharp dissection, staying as close as possible to the edge of the tumor which may or may not be encapsulated, the lesion is removed. Careful hemostasis is necessary at all times The pancreatic tissue is closed by interrupted sutures of silk and the capsule reunited. The region of the pancreas should be drained.

Large pseudocysts of the pancreas demand surgical attention. The ideal procedure is the removal of the entire cyst. Usually this is not possible and one must be content with excision of a portion of the cyst and marsupiali zation of the remainder The contents of the cyst are first aspirated, the

Chronic Pancreatitis

In these cases one must deal with two factors first, the cause of the disease; and second, the disease itself The common duct should be opened and carefully probed and explored to rule out the presence of common-duct stone. A badly diseased gallbladder should then be removed. The only treatment available for the pancreatitis is prolonged drainage of bile, and this is best accomplished by the insertion of a T tube in the common duct. This tube can be left in for several months and removed only when it is found after trial clamping of the tube that the bile is no longer obstructed. One may likewise demonstrate the patency of the common duct by the injection of radiopaque material into the tube. If the gallbladder is not too badly diseased it is probably wiser not to remove it, but to insert a drain in the gallbladder as well as the T tube in the common duct. Then in the event that the prolonged drainage of the bile has not cured the pancreatitis, at a later operation the gallbladder can be anastomosed to the duodenum to relieve the obstructive jaundice.

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abdominal viscera protected by moist packs. The omentum which lies in front of the cyst will be so thinned out as to be scarcely recognizable but may be divided to give access to the base of the cyst. When the contents have been emptied, by a combination of blunt and sharp dissection, the walls of the cyst are followed back to their place of origin. None of the cyst wall should be cut off until it is certain that the entire cyst can be removed, because enough of the cyst wall must be preserved to make marsupialization possible.

Malignant Tumors

If no metastasis is evident in the liver in the glands of the gastrohepatic omentum or in the retroperitoneal glands and carcinoma is found to be present in the pancreas the feasibility of removing the tumor must be considered. If the tumor is fixed to any neighboring organ, such as the stomach, it may not be easy to determine whether the tumor is primary in the pancreas or in the stomach. In either case it is probably inoperable. It is true that occasionally carcinoma of the stomach is removed when it is necessary to shave off part of the adherent pancreas, but if extension of the tumor has occurred to that degree the operation is rarely worth while. Evidence of fixation of the pancreas to the posterior abdominal wall should next be sought for since the pancreas should normally have a certain amount of mobility A primary carcinoma in the body or the tail of the pancreas, if seen early and unfortunately this rarely happens, can be removed without great technical difficulty but when the tumor is in the head of the gland a very extensive operation is required. The blood supply of the second part of the duodenum is so intimately connected with the pancreas that removal of the head of the pancreas almost inevitably entails sacrifice of the circulation to the duodenum, and a portion of the duodenum must be removed. This in turn requires the provision of a new point of entrance for the common duct, or an anastomosis of the gallbladder to a part of the intestine farther down. The removal of the duodenum of course also necessitates an anastomosis between the jejunum and the stomach. All this surgery and in addition the danger of leakage from the pancreatic stump make an operation that carries a high mortality

When a firm hard mass is felt in the head of the pancreas and with it is associated dilatation of the common-bile duct and gallbladder one may be reasonably sure that one is dealing with a carcinoma of the pancreas If there is any doubt about it, a small piece of the gland should be excised for immediate frozen section before any radical surgery is instituted. Differentiation between chronic pancreatitis and carcinoma of the pancreas by palpation alone is sometimes too difficult for even the most experienced surgeon even after biopsy there may occasionally be a question. As a compromise measure the gallbladder may be anastomosed to the jejunum.

If one later concludes that the patient has carcinoma of the head of the pancreas, another operation can be done and one stage of the radical procedure will have already been accomplished. If the surgeon feels that the chances are more in favor of chronic pancreatitis, a more conservative measure is to insert a T tube in the common duct for prolonged drainage.

TECHNIQUE

Marsupialization of Cyst

Moist packs are inserted around the cyst and a trocar is used to aspirate the contents. If an excess of tissue is present in the cyst wall, a portion of the wall is excised, as it is only necessary to have enough tissue to extend to the parietal peritoneum. At this point, by the use of chromic catgut and continuous or interrupted sutures, the cyst wall is attached to the peritoneum, usually near the center of the abdominal incision. A Penrose drain is inserted into the cyst cavity and the fascia and skin are closed above and below the cyst opening by the usual technique. The drain is allowed to remain for a few days, until firm attachment has taken place between the cyst wall and the peritoneum.

Cholecystogastrostomy Cholecystojejunostomy and Cholecystoduodenostomy

These procedures are used whenever it is desirable to short-circuit the bile around the common duct into the intestine. The anastomosis may be made between the gallbladder and the stomach, duodenum, or jejunum, but the duodenum is the most desirable site if it can be approximated to the gallbladder If the duodenum is to be removed, a cholecystojejunostomy should be performed. The same technique is applicable regardless of where the anastomosis is made. A site on the stomach or bowel that can be approximated to the fundus of the gallbladder without undue tension is selected and grasped with Allis forceps about 3 cm. apart. If there is too much tension, the gallbladder may be loosened slightly from its bed. Except in the case of the duodenum, a Doyen clamp is applied to prevent leakage during the course of the operation. The Allis forceps are now replaced by stay sutures of catgut. Moist packs are inserted to isolate the field of operation, and the gallbladder is emptied by means of a trocar Stay sutures are now applied near the fundus of the gallbladder about 3 cm. apart, and approximated to those attached to the stomach or bowel. By means of a continuous serosal and submucosal suture of catgut, the fundus of the gallbladder between the stay sutures is attached to the stomach or bowel (Figure 96A) An opening 2.5 cm. long is made through the wall of the stomach or bowel just anterior to this sutured line, and the opening made by the trocar in the fundus of the gallbladder is enlarged to the same size. Another continuous catgut suture is then used

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to unite the edges of the wound of the gallbladder (Figure 98B) to th of the stomach or bowel taking in all the layers, and this is continu around the anterior part of the openings as in a gastro-enterostomy (Fi

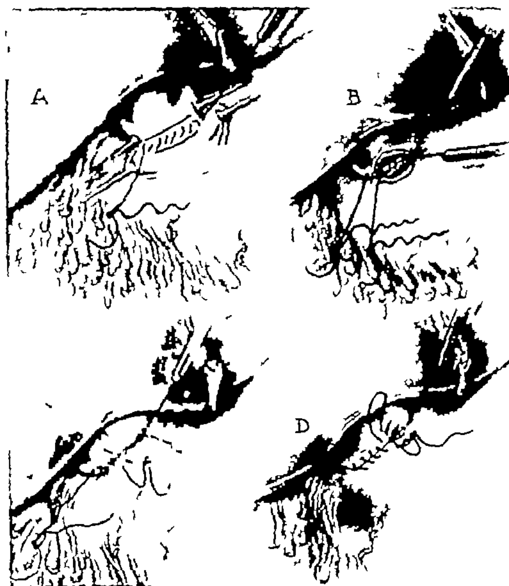


Fig. 98 Cholecystogastrostomy A. The first row of sutures between the gall bladder and the stomach has been inserted, and the incisions have been marked. B The second posterior line of sutures has been inserted. C The first anterior line of sutures is being inserted D The first suture is continued around to make the second anterior row of sutures

ure 98C) The first or serosal suture is now continued around the fron and back to its starting point (Figure 98D) A third continuous sutu may be put in on the anterior surface for additional safety if desired, an a portion of the omentum is wrapped around the anastomosis to guar against leakage. The packs are removed and a Penrose drain is inserte to the region of the gallbladder

Transplantation of the Common Bile Duct

This procedure is not as easily done as cholecystenterostomy and there is more tendency for the anastomosis to contract and produce obstruction of the bile but ascending infection is less likely to occur The common duct is dissected free from the gastrohepatic omentum and severed as far down as possible. The distal end is ligated with silk. Into the proximal end, a portion of a catheter about 4 cm long is introduced and sutured with one stitch of silk so that it projects half way into the end of the common duct. Before inserting the catheter into the duct, a small portion of the end of the catheter may be turned back to form a cuff An opening just large enough to admit the catheter is made in the bowel, the catheter is introduced, and the duodenum is drawn up over it to meet the end of the common bile duct. Interrupted silk sutures are used to approximate all the layers of the duodenum to the end of the duct. When this row is completed the duodenum may be pushed up still farther and a similar layer of sutures introduced The area of anastomosis is surrounded by omentum for protection, and a Penrose drain is inserted to the area. Special metal tubes made of Vitallium are available also and may be used in place of the catheter

Partial Pancreatectomy

A transverse incision gives the best exposure for this operation. A wide opening is made in the gastrocolic omentum, ligating vessels as necessary With the stomach lifted upward and the colon held downward as much as possible by packs, the peritoneum covering the pancreas is incised starting at the tail branches coming off the splenic artery and vein are carefully clamped, cut, and tied, using great care not to tear the main vessels. Ligation is continued along the body of the gland to just above the point chosen for resection, where a Doyen clamp is gently applied. The gland is severed by a V-shaped incision, the pancreatic duct is located, ligated with silk, and the substance of the pancreas is brought together over the duct by means of mattress sutures of silk. Drainage should be instituted to the lesser sac, and the opening in the gastrocolic omentum is closed except for the passage required by the drain. If the splenic artery or vein should be severely injured, it is ligated and a splenectomy is performed.

Partial Pancreatectomy with Removal of the Head of the Pancreas and the Duodenum

This operation may be done in one or two stages. When the two-stage procedure is chosen, at the first operation the common bile duct is cut and tied with silk, the gallbladder is anastomosed to the jejunum, and a posterior gastrojejunostomy is performed. The operation is done through

a right paramedian incision and the technique is that described under gastrojejunostomy and cholecystojejunostomy If it is proposed to do the operation in one stage, a transverse upper abdominal incision is the more satisfactory exposure If it is necessary this incision may be extended downward through the paramedian region on the right. Conversely if the original intention was to do a two-stage operation and a right paramedian incision has been made the incision may be extended transversely across the abdomen and the operation completed in one sitting. Ten days or two weeks after the first stage of the operation, the second stage is performed, which consists of removing the duodenum and head of the pancreas by the method about to be described below

If the operation is to be done in one stage, attention should first be directed to mobilization of the duodenum, since it is easier to resect the duodenum before the posterior gastrojejunostomy and cholecystojejunostomy have been done. The peritoneum along the lateral surface of the duodenum is incised. The duodenum is grasped with Allis forceps and pulled inward. Just above the pylorus, the right gastric artery is cut between clamps and tied, and an opening is made in the gastrohepatic omentum. A finger is inserted in this opening and the upper end of the duodenum and pyloric region are lifted up The right gastro-epiploic artery is identified in the gastrocolic omentum, doubly clamped, cut, and ligated. Two small Payr clamps are introduced and closed on each side of the site chosen for section which should be just above or below the pylorus, and a cut is made between them. The clamp on the duodenum is laid aside covered with a moist pack, and attention is directed to the stump of the stomach. With a curved needle and fine chromic catgut, a continuous suture is introduced, which passes through the serous, muscular and submucous layers on one side over the clamp, and into the same layers on the other side and continues in this manner over the length of the stump. This suture is tightened as the Payr clamp is removed, and the stump inverts itself This is further reinforced by another layer of chromic catgut. The common-bile duct is identified in the gastrohepatic omentum, isolated, doubly clamped, divided, and the two severed ends are tied with silk. Through an opening in the gastrocolic omentum, the duodenum is doubly clamped and divided just above the ligament of Treitz. The distal end is closed by the method described above for the pyloric end of the stomach. The duodenum and the head of the pancreas are gradually mobilized and the gastroduodenal artery is identified and ligated (Figure 97A) The pancreas is lifted up away from the mesenteric vessels, and at the point chosen for resection it is doubly clamped with rubber covered clamps. A cut is made between the two clamps, the cut on the distal stump preferably wedge-shaped, to facilitate closure. The pancreatic duct is identified in the stump grasped, and ligated with silk using a transfixion technique if necessary Mattress su-

tures of silk are used to close the pancreatic tissue over the stump of the duct (Figure 97B) The duodenum and the head of the pancreas are released and removed. The opening in the gastrocolic omentum is sutured to the stomach around the site of the proposed gastrojejunostomy leaving room, however for the passage of one or two Penrose drains to the neigh-

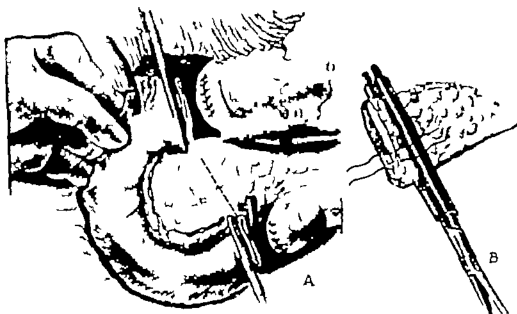


FIG. 97 *Removal of the Head of the Pancreas and the Duodenum.* A. The duodenum has been severed from the stomach and the stump of the stomach closed. The distal end of the duodenum has been similarly cut loose from the beginning of the jejunum and the jejunal stump closed The duodenum has been mobilized by cutting the lateral peritoneum, and the proposed incision across the head of the pancreas is shown by a dotted line. B The wedge-shaped incision in the stump of the pancreas is being closed by interrupted sutures The stump of the duct has been ligated.

borhood of the pancreatic stump The first loop of jejunum is brought up and anastomosed to the posterior surface of the stomach, as described under posterior gastrojejunostomy If a cholecystojejunostomy has not already been performed in a first-stage operation, the jejunal loop leaving the stomach is now brought up in front of the colon and anastomosed to the gallbladder (Figure 98) Because of the long jejunal loop it is advisable to make an anastomosis between the ascending and descending limbs of the jejunum at the point where it starts up toward the gallbladder A number of modifications have been suggested for this operation one that has considerable merit entails the implantation of the pancreatic stump in an opening made in the side of the jejunum or in the open end of the jejunum, where it is cut off from the duodenum. This may have some value in lessening the not inconsiderable danger of leakage of pancreatic juice With the object of minimizing the danger of

ascending infection through the gallbladder stoma, Whipple[2] prefers to make a Roux type of anastomosis, connecting the gallbladder on to the end of the open arm of the jejunal Y This may increase somewhat the danger of jejunal ulcer and makes another anastomosis necessary but if a two-stage procedure is done, the latter is of little consequence. In the

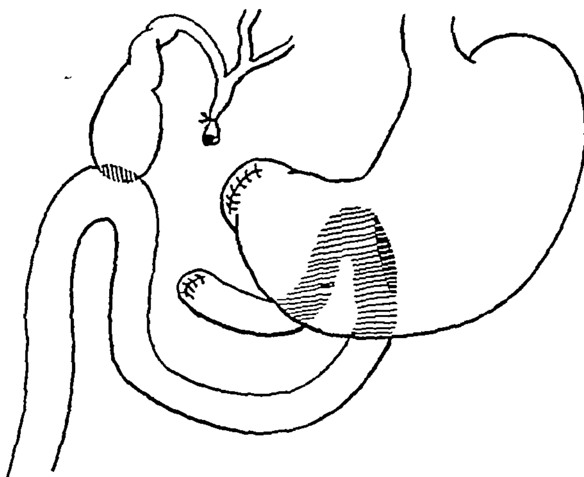


FIG. 93 *Diagram of the Anastomoses after Partial or Complete Pancreatectomy*

first stage the common duct is divided, a posterior gastrojejunostomy is performed, the jejunum is transected well below the ligament of Treitz, and the distal end is brought up and anastomosed to the gallbladder The proximal end of the jejunum is anastomosed to the side of the distal loop. At the second stage the duodenum and head of the pancreas are removed by the method already described. Whipple later advised transplantation of the end of the common duct into the jejunum instead of cholecystenterostomy and if the duct is large has anastomosed it to the open end of the jejunal Y

2 Whipple, A. O "Surgical Treatment of Carcinoma of the Ampullary Region and Head of the Pancreas, *Am. J Surg* 40-260, 1938.

POSTOPERATIVE TREATMENT

Parenteral fluids should be continued and Vitamin K given if indicated. If a T tube has been placed in the common duct to relieve obstruction caused by pressure from an enlarged head of the pancreas, it should be left in place for a long time usually several months before removal the tube should be clamped off for several days at a time, to be sure that the bile can enter the duodenum. The normal passage of bile will be indicated by the color of the stools and by absence of the chills and fever that common-duct obstruction usually evokes. Cholangiograms may be helpful in determining the condition of the biliary tree. Pancreatic or biliary fistula mav follow operations on the pancreas. The former usually closes spontaneously but the skin should be protected in the meantime by providing continuous suction to draw off the secretion and by coating the skin as mentioned in the chapter on The Skin and Subcutaneous Tissue. Biliary fistula is apt to be more persistent and the patient should take bile by mouth to counterbalance its loss. Duodenal fistula is also not uncommon and until it closes, which it usually does in a few weeks, the skin should be protected from the discharge. A drain placed in a marsupialized pancreatic cyst can usually be removed in about one week, but the patient will have to wear a pad over the stoma for some period of time. After total pancreatectomy the patient will henceforth require daily insulin, but the dose often becomes standardized at not more than 40 units per day

CHAPTER XV

The Spleen

PREOPERATIVE TREATMENT
INCISION
EXPLORATION
LESIONS OF THE SPLEEN
  Movable Spleen
  Rupture of the Spleen
  Abscess
  Splenomegaly
  Tumors in the Spleen
  Cysts of the Spleen
  Tuberculosis of the Spleen
TREATMENT
TECHNIQUE
  Splenectomy
  Fixation of the Spleen or Splenopexy
  Suture of the Spleen
  Drainage of Splenic Abscess
POSTOPERATIVE CARE

The Spleen

PREOPERATIVE TREATMENT

Anemia should be corrected by transfusions, with the exception in hemolytic icterus blood should not be given because it is rapidly he lyzed. In this condition adrenalin should be given by hypodermic in tion preoperatively since this causes the spleen to surrender a l amount of its blood to the general circulation. In cases of rupture of spleen blood transfusions are especially important to relieve or prev shock. Hypoproteinemia, which may be severe particularly in Ba disease, should be corrected. Operation for thrombocytopenic purpur hemolytic icterus should be performed whenever possible in a pe when the symptoms are least severe If the patient has a tendency bleed, spinal anesthesia should be avoided.

INCISION

The spleen is approached through a *left paramedian, transverse,* midline incision.

EXPLORATION

The surgeon, standing at the left side of the patient, passes his hand into the upper quadrant to determine the size and contour of spleen and its degree of fixation. Accessory spleens are not rare and t may enlarge greatly after splenectomy They are usually located in region of the hilum of the spleen, but may be found in the ligame attached to the spleen, near the pancreas, in the omentum in the wall the bowel or stomach, in the liver or elsewhere in the abdominal cavi If splenectomy is performed for a condition such as thrombocytope purpura, one should be sure that no accessory spleen is left in. Becau of the common association of enlargement of the spleen with cirrhosis the liver the surface of the liver is next investigated. A systematic a routine investigation of the other contents of the abdominal cavity is n carried out. *Incomplete preoperative study may* lead to the discovery t

what was thought to be a large spleen is not a spleen at all but an enlarged left kidney, a greatly enlarged liver a retroperitoneal tumor a pancreatic cyst, or a mass of carcinoma in some part of the gastro-intestinal tract. In the case of retroperitoneal sarcoma, all one can do in most instances is remove a piece of the tumor to confirm the diagnosis. On the other hand not all carcinomata large enough to be mistaken for an enlarged spleen are inoperable, and one should determine the operability of such a tumor without regard to its size, by its location, its fixation its extension and the presence or absence of metastasis. If the mass should happen to be a tumor of the kidney it may be approached through the posterior parietal peritoneum and nephrectomy performed. Pyonephrosis on the other hand, should be operated on only by the lumbar route, after closing the abdominal incision. There is practically never any occasion to combine another operation with primary splenectomy If stones are found in the gallbladder and they are said to be very frequent in hemolytic icterus, cholecystectomy should be performed at a subsequent operation. On the other hand, the spleen is often removed as an incidental procedure in extensive operation for carcinoma of the stomach or pancreas.

LESIONS OF THE SPLEEN

Movable Spleen

This occurs most commonly in women but may occur in men when the spleen is abnormally large. Elongation of the ligaments that normally attach the spleen takes place, and the spleen drops downward, pulling on the stomach. Occasionally the pedicle of the spleen may become twisted, with acute congestion or necrosis of the organ.

Rupture of the Spleen

Since wounds of the spleen tend to bleed freely as soon as the peritoneal cavity is entered there will usually be a gush of blood. The spleen is frequently encased in a large blood clot, which must be removed before the extent of the injury can be determined. The wound may be of the spleen itself or of the splenic vessels. Spontaneous rupture of the spleen may take place in typhoid fever or malaria.

Abscess

An abscess may be metastatic and associated with septicemia, or may result from the degeneration of an infarct. Over a superficial abscess there is a deposit of fibrin, and the spleen feels soft and may be adherent to neighboring viscera.

Splenomegaly

There are a large number of diseases that cause enlargement of the spleen, and except in unusual instances it is not possible for the surgeon

by gross examination of the spleen to make a diagnosis. The association of cirrhosis of the liver with enlargement of the spleen and anemia may constitute the syndrome of Banti's disease, but enlargement of the spleen is also very commonly an accompaniment of simple cirrhosis. Thrombocytopenic purpura is another disease associated with moderate enlargement of the spleen, in this condition areas of hemorrhage will often be seen on the surface of the body or viscera. The familial type of hemolytic icterus is characterized by a mild degree of jaundice and moderate enlargement of the spleen. The spleen is firm, and the capsule is tense and may be adherent to the diaphragm. With these exceptions, the various types of splenomegaly are of no concern to the surgeon unless, as in Gaucher's disease, the spleen by its very weight may become so burdensome to the patient as to demand its removal.

Tumors of the Spleen

With the exception of occasional metastatic carcinoma and rarer sarcoma, tumors of the spleen are exceedingly unusual. Probably angioma would be the most likely to be met with.

Cysts of the Spleen

Hydatid cysts of the spleen may rarely occur and there are occasionally seen cysts due to the degeneration of an infarct or a hematoma. Much less often, actual neoplastic cysts of the dermoid type may be observed. Congenital cystic disease, similar to that in the liver or kidney may be encountered.

Tuberculosis of the Spleen

This may be a part of disseminated miliary tuberculosis, but not infrequently a solitary tuberculous nodule is seen in the spleen, sometimes enclosed in a calcified wall. As a rule the treatment of neither of these conditions is surgical but occasionally splenectomy may be done for a large tuberculoma.

TREATMENT

If a laceration of the spleen is small it may be advisable to suture it, but most injuries of the spleen or splenic vessels are more simply treated by splenectomy The same is true for movable spleen. In the case of an abscess of the spleen, one must of course take into consideration the condition of the patient. The usual treatment is to drain the abscess, but occasionally splenectomy may be done. Splenectomy is also indicated for thrombocytopenic purpura, if conservative treatment has failed, for familial spherocytic hemolytic jaundice for Banti's disease, if the liver damage is not too advanced, and for tumors and cysts.

TECHNIQUE

Splenectomy

The first objective in removing the spleen is to deliver the organ into the wound. After the colon and stomach have been packed off with moist packs, the hand is insinuated between the anterior abdominal wall and

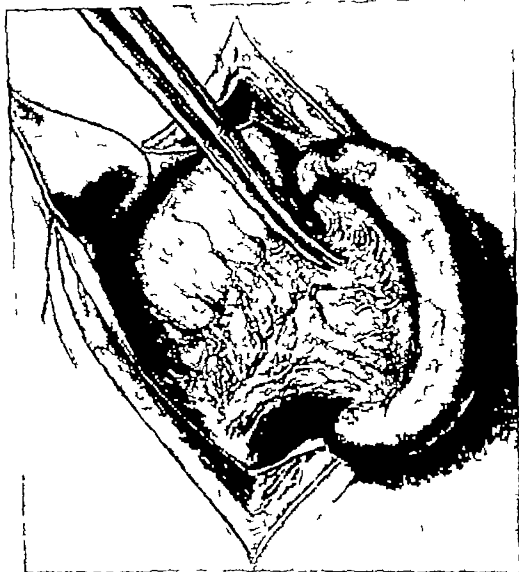


Fig. 99 *Splenectomy* Clamping the short gastric vessels.

diaphragm in front and above and the spleen behind and below If the adhesions found are so heavy as to resist stripping, they must be doubly clamped and divided, by the judicious use of the fingers to feel for heavy bands, clamping them and cutting them with scissors as they are approached, the spleen is gently freed from its attachments. This is a most

dangerous part of the operation since, although in many cases th cedure is extremely simple, in other cases, particularly of large s with dense adhesions, hemorrhage may be profuse and its conti

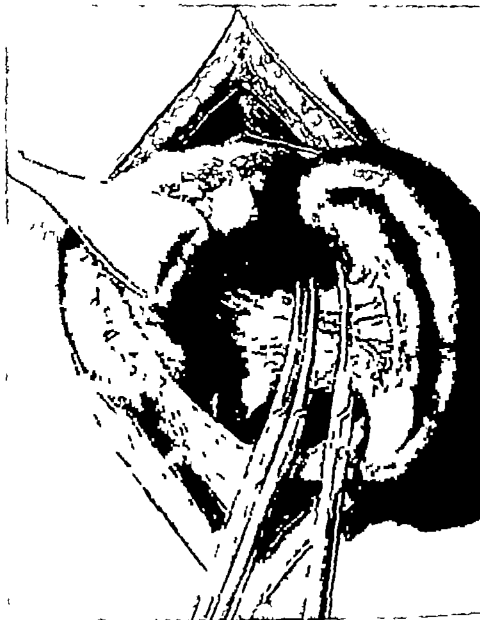


FIG. 100 *Splenectomy* Pedicle of spleen freed and clamped preparator division.

tremely difficult As soon as the spleen has been freed (Figure 99) cavity left by its removal should be filled with a large moist pack. helps to stop bleeding and keeps the spleen in a position when pedicle can be most easily dealt with. The pedicle should be exan and cleared on both surfaces, and it should be remembered tha splenic veins are torn very easily The tail of the pancreas, which

be in contact with the hilum of the spleen should be gently separated from the splenic pedicle and pushed aside. The pedicle is now clamped with heavy forceps using one near the spleen and two more proximally (Figure 100) The spleen is cut off below the outside forceps. A suture ligature is now applied to the pedicle proximal to the inside forceps, and as the ligature is tightened the forceps are removed so that the ligature falls in the crushed line left by the removal of the clamp A second ligature is now put on between this tie and the remaining forceps, and tightened as the latter is removed. The gauze packing is removed from the splenic cavity which is inspected for hemorrhage, and any bleeding points are caught and tied. The incision is closed without drainage. If there is any doubt about the security of a ligature on the pedicle, one or two clamps may be left on the pedicle and removed only after seventy two hours. If there continues to be oozing from the bed of the spleen, a gauze pack may be left in position and removed slowly after two or three days.

Fixation of the Spleen or Splenopexy

Occasionally it may seem advisable to fix the spleen in position rather than to remove it. This may be accomplished by making a transverse incision through the posterior parietal or diaphragmatic peritoneum wide enough to admit the lower half of the spleen. The organ is inserted in the pocket thus formed, and the opening is narrowed down by suture sufficiently to hold it in place without constricting the pedicle. A few sutures are placed between the pedicle and peritoneum to aid in fixation.

Suture of the Spleen

The capsule of the spleen is extremely thin and the splenic tissue is very friable. One should not attempt to suture any but the smallest laceration unless there is a good reason for not removing the spleen. Mattress sutures of catgut on a blunt needle are introduced at intervals close enough to control the bleeding, and, as they are carefully tightened, the injured areas are brought together The area may be further protected by applying a tab of omentum and fixing it in place.

Drainage of Splenic Abscess

If it is decided to drain an abscess of the spleen, the abdominal cavity is packed off and an incision is made in the abscess. The finger or a pair of forceps may be introduced, the latter opened, and a Penrose drain inserted into the abscess.

POSTOPERATIVE CARE

Transfusions should be given if there has been much loss of blood. Fluids may be given by mouth as soon as nausea has subsided. The po-

sition of the patient should be changed frequently and carbon dioxide and oxygen inhalations should be used to lessen the danger of pneumonia. The plasma proteins should be maintained at a normal level to minimize the danger of wound disruption. Portal thrombosis is an unusual but dreaded complication, which I have encountered only once- but if thrombosis is present in the splenic vein at operation for Banti's disease, Dicumarol therapy should be used postoperatively as a preventive measure.

CHAPTER XVI

The Stomach

The Stomach

Lesions of the stomach are so common and so accessible to approach that gastric surgery has come to occupy a most important part of the field of general surgery Experimental investigations have brought to light certain physiologic principles, a knowledge of which is essential to its correct performance.

PREOPERATIVE PREPARATION

Dehydration, low blood chlorides and proteins, and vitamin deficiency should be remedied by giving saline solution and protein hydrolysates intravenously and by the administration of vitamins C and B Blood transfusions should be given for anemia, and plasma may be used to combat the low blood protein. When pyloric obstruction is present, the stomach should be emptied by a tube on the evening before operation, and lavage should be performed one or two hours before surgery

INCISION

The usual incision for operations on the stomach is the upper right paramedian or right rectus. When a high resection of the stomach is contemplated, however a left paramedian or left rectus approach may give better exposure.

EXPLORATION

When the abdomen has been opened, the greater omentum is grasped and pulled downward. This will bring into view the greater curvature of the stomach. The hand is then inserted into the abdomen and run over the surface of the stomach to search for areas of induration or adhesions. The stomach is grasped with Allis forceps and pulled still farther downward, so that the lesser curvature and the duodenum may be inspected. By pressing the stomach and duodenum backward against the posterior abdominal wall masses in the lumen or on the posterior surface may be palpated. The lesser omentum should be investigated by inspecting and

feeling it to determine whether any indurated areas or enlarged glands are present. If no acute inflammatory disease or perforation is present, a general abdominal exploration is begun by examining the surface of the liver searching for irregularities or softened areas. The gallbladder is next examined to determine the presence or absence of stones and other evidence of chronic cholecystitis A finger is inserted into the foramen of Winslow in order to feel the structures in the lesser omentum and to rule out the presence of free fluid in the lesser sac at the same time the head of the pancreas is palpated. If chronic cholecystitis, particularly with stones, is present one may remove the gallbladder at the conclusion of the surgery on the stomach unless the operation has been too prolonged or the lesion is a perforated ulcer The colon should next be investigated, looking particularly for evidence of adhesions between the transverse colon and the stomach. A hand should be passed down into the pelvis to determine the condition of the pelvic organs and the appendix. Unless some acute inflammatory condition is found in the pelvis that demands immediate surgery and that necessitates the postponement of operation on the stomach, no major surgical procedure should be done on the pelvic organs in association with gastric surgery but the appendix may be removed. Finally the size of the kidneys and spleen should be determined.

LESIONS OF THE STOMACH

Foreign Bodies

These may consist of swallowed objects such as nails and pins, balls of plant fiber or hairs known as bezoars or rarely large numbers of parasites such as round worms. Foreign bodies in the stomach, unless they have partly penetrated the wall of the organ, are usually movable and their nature can often be determined by feeling them through the wall of the stomach.

Rupture and Wounds of the Stomach

As soon as the abdomen is opened, the presence of free fluid and food particles is evidence that there is an opening in the stomach or duodenum. Wounds of the stomach are commonly associated with wounds of other parts of the gastro-intestinal tract and there is apt to be a great deal of free blood present due to tearing of blood vessels. The lesions are usually obvious enough as soon as the stomach has been brought into view It is probably unnecessary to say that a bullet wound on the anterior surface of the stomach is apt to be associated with a similar wound on the posterior surface.

Congenital Hypertrophic Pyloric Stenosis

This condition is seen only in babies and is more frequent in males than in females. The stomach is usually dilated and its walls may be thickened.

The pylorus is almost as hard as cartilage and the area of induration forms a fusiform mass, smooth and freely movable and somewhat whiter in color than the rest of the stomach.

Ulcer

Gastric ulcer is not infrequently seen but it occurs only about one-tenth as often as duodenal ulcer The lesion is usually single and is found most commonly in the pyloric end of the stomach on the posterior surface or near the lesser curvature. Occasionally two or more ulcers may be seen when one is present on the posterior surface, there may be another directly opposite it on the anterior surface, the so-called 'kissing ulcer If inflammatory reaction has extended through the wall of the stomach, a portion of the omentum may be adherent at the site of the lesion, or the posterior wall of the stomach may be attached to the posterior abdominal wall. The wall of the stomach in the region of the ulcer crater and for a considerable distance beyond it is thickened and indurated. A small posterior ulcer may be detected by making an opening through the lesser omentum, inserting the index finger against the posterior surface of the stomach, and making pressure with the thumb on the anterior surface, rolling the stomach wall between the finger and thumb A gastric ulcer may vary in size from 2 mm. to several centimeters but when confronted with one of the larger ulcers one should be certain that one is dealing with a benign lesion and not a carcinomatous ulcer It may not be easy in any case to determine whether an ulcer is malignant or not, and as a rule such a differentiation should be attempted only by microscopic section regardless of the size of the lesion. Nearly all ulcers along the greater curvature are malignant. The peritoneum covering the region of the ulcer is usually smooth, but sometimes the contraction of scar tissue may make a definite stellate appearance and when gauze is rubbed on the surface near the site of the ulcer punctate hemorrhagic spots will appear through the peritoneum. Occasionally the under surface of the liver or the gallbladder may be adherent in the region of the ulcer Such adhesions should be separated with great care, because of the possibility that there may be a hole in the stomach wall at that point. When an ulcer has been present near the pyloric sphincter for some time, there may be stenosis of the opening By grasping the region of the sphincter with the finger on the anterior surface of the duodenum and the thumb on the anterior surface of the stomach, the two may be approximated and it should be possible normally to bring them together

An acute perforated gastric ulcer located on the anterior surface of the stomach will make its presence known, as soon as the abdomen is opened, by the presence of gastric juice, bile and food particles in the peritoneal cavity When the ulcer is on the posterior surface, on the other hand, the foramen of Winslow may become sealed by inflammatory exudate, and

little or no free gastric fluid may be seen in the general peritoneal cavity but the presence of such fluid is readily detectable in the lesser sac. The size of the actual perforation is commonly only about 2 mm. but larger openings occasionally occur When a perforated ulcer is situated on the anterior surface of the stomach and operation is performed early there seems to be little tendency for the omentum to close the hole, and by pulling the stomach wall into view it is readily apparent. A good guide to the site of the perforation is the fluid welling out of the stomach. The perforation of an ulcer of the stomach may be acute, and this is the type associated with free leakage of gastric contents into the abdominal cavity and profound symptoms. Sometimes in acute, and often in subacute cases, the opening becomes partly or completely plugged by omentum or by a neighboring organ, with the result that there is little leakage of gastric contents and the symptoms are less pronounced. At the other extreme is the chronic perforation, in which the perforation occurs in an area already walled off by a neighboring viscus, most commonly the pancreas. Here there is no leakage of gastric contents and the symptoms are largely those of an inflammatory disease of the upper abdomen. The best approach to a perforated ulcer of the posterior surface or lesser curvature of the stomach is through the gastrohepatic omentum. As soon as a sufficient area of omentum has been cut and ligated, the stomach may be grasped with Allis forceps and pulled down so that the posterior surface comes to lie in front. This eversion of the stomach should of course be done in the area where induration of the stomach wall is apparent.

Hemorrhage coming from an ulcer of the stomach or duodenum may be indicated, as soon as the abdomen is opened, by the bluish color of the small intestine due to the blood in it. The location of the ulcer can usually be determined by palpation, but it may be necessary to open the stomach by an incision in the anterior surface for visual inspection. Occasionally gastro-intestinal hemorrhage, which was thought to be due to bleeding ulcer may be found to be due to cirrhosis of the liver; in such cases evidence should be seen of enlargement of the vessels of the collateral circulation together of course with a nodular liver Sometimes this process is part of the complex known as Banti's disease, and if the spleen is enlarged it should be removed. Hemorrhagic areas scattered over the viscera underneath the serosa are evidence of thrombocytopenic purpura, here again splenectomy is indicated.

Benign Tumors

The most common of these are adenomatous polyps, but fibromas, myomas, leiomyomas angiomas, lipomas, dermoid cysts and hypertrophy of the mucosa with polyposis may occur The adenomatous polyps are fairly firm, movable tumors, which may be palpated through the gastric wall without difficulty They are sometimes multiple and are commonly

about 2.5 cm in diameter The presence of a movable rounded tumor without induration of the walls of the stomach should make one think of a benign tumor but the nature of the tumor may not be evident until after it has been removed. Polyposis of the stomach is characterized by diffuse enlargement of the gastric mucous membrane into globular polyps, so that the lining of the stomach is apparently one mass of tumors. The process may be confined to the pyloric region, but not uncommonly extends into the body of the stomach.

Carcinoma of the Stomach

The most common site of carcinoma of the stomach is the antrum near the pylorus and on the lesser curvature but it may be found on the greater curvature and in any part of the stomach. If the tumor extends to the anterior surface of the stomach, anything from a slight irregularity to a large mass may be seen. Adhesions often occur between the stomach wall and omentum liver gallbladder or colon on the anterior surface and the pancreas on the posterior surface. The wall of the stomach is always thickened, and a definite tumor can often be felt occupying the lumen. Most commonly the lesion takes the form of a large ulcer with elevated indurated margins, and the area of the ulcer crater and margins are associated with hardening and thickening of the gastric wall. Occasionally in the linitis-plastica type of carcinoma, the entire wall of the stomach may be diffusely thickened and the organ contracted, due to fibrosis of the submucosa and muscularis this type of carcinoma may also, of course be associated with metastatic involvement of the neighboring lymph glands. A carcinoma that has been present for some time tends to perforate, and the perforation may extend to a portion of the neighboring bowel, most commonly the transverse colon, so that a fistulous communication takes place between the stomach and colon. The tumor extends to the wall of the colon in that region and may produce a growth there even larger than that in the stomach. Extension of the lesion occurs into the glands and fatty tissues of the lesser omentum, and may surround and compress the common bile duct to produce jaundice but extension to the duodenum rarely occurs. Metastasis may take place to the liver where multiple nodules may be felt, or generalized carcinomatosis with ascites and hundreds of small implants on the peritoneal surface throughout the abdominal cavity may be seen. Rarely the only evidence of extension of the tumor may be the growth of an implant on the rectal shelf in the pelvis or on one of the ovaries (Krukenberg tumor) The mobility of a gastric carcinoma is some indication of the amount of extension that has taken place and this should be carefully determined, if necessary a wide incision may be made through the gastrocolic omentum to examine the degree of attachment of the stomach to the pancreas. Not infrequently when one is convinced that a lesion of the stomach is a benign ulcer

when it is removed and examined under the microscope it may prove to be carcinoma. The same situation may occur occasionally in the case of what was thought to be a simple adenoma. The frequency of carcinoma of the stomach should lead one to view with suspicion any benign gastric lesion, removing enlarged glands when present for immediate biopsy practicing a wide excision of the lesion itself and being prepared to do a more radical operation if the report of the pathologist indicates malignancy

Sarcoma

This tumor is rarely seen but resembles carcinoma closely in its gross appearance.

Syphilis of the Stomach

One form of this disease may resemble linitis plastica, because of diffuse infiltration of the entire organ with thickening and contracture In other cases single or multiple gummata or more diffuse nodular infiltration of the stomach may occur An operation for this disease should be avoided by routine serological examination of the patient before surgery and when a positive agglutination is obtained a therapeutic test should be done in doubtful cases before concluding that the lesion in the stomach is carcinoma.

TREATMENT

Foreign Bodies

These are removed by simple gastrotomy Frequently the object can be grasped through the stomach wall and held in place while an incision is made over it preferably on the anterior surface of the stomach three or four inches above the pylorus If the foreign body cannot be located, an incision is made through the gastric wall and, after an aspirator has been inserted to empty the contents, any solid object remaining will be readily felt. The incision is enlarged enough to admit the passage of the foreign body After its removal, the wall of the stomach is closed by a continuous 00 chromic catgut Connell suture, reinforced by a continuous Lembert suture in the serosa.

Wounds of the Stomach

The laceration is located, surrounded by moist packs, and the torn edges are grasped with Allis forceps. Any large, freely bleeding vessels are caught and tied, and the opening is closed by the method described above.

Congenital Hypertrophic Pyloric Stenosis

In these cases the Ramstedt operation is almost universally used, with excellent results.

Gastric Ulcer

The gastric ulcer for which surgery is performed is one that has refused to heal under medical treatment, has produced unrelievable pyloric obstruction has bled repeatedly or has perforated. In addition to this, there is the ulcer discovered in the course of an operation for some other disease, and here the treatment in certain cases may be more conservative. If such an incidental ulcer is small (less than 2.5 cm. in diameter) it may simply be excised and subjected to immediate microscopic examination. If no evidence of malignancy is found no further surgery on the stomach is done. If the ulcer is large or is located on the greater curvature, however the chances of its being malignant are so great that partial gastrectomy is indicated even if the primary purpose for which the operation was performed cannot be accomplished.

A small ulcer on the anterior wall of the stomach may be very simply removed by making an elliptical incision around the ulcer and then closing the defect by an inverting suture of the Connell type, followed by a layer of Lembert sutures. When the lesion is located on the posterior surface of the stomach the gastrohepatic omentum may be incised and the stomach everted downward, or if it is nearer the greater curvature the gastrocolic omentum may be incised and the stomach pulled upward to expose the lesion, and simple excision performed. If neither of these procedures can easily be done, an incision may be made through the anterior wall of the stomach, and the lesion on the posterior wall removed through this.

An ulcer near the lesser curvature may be removed by a wedge type of resection. A sleeve resection entails as much risk as partial gastrectomy does not change the physiologic conditions in the stomach, and may interfere with gastric function.

In an operation performed primarily for the treatment of gastric ulcer in other words when medical treatment has failed, partial gastrectomy is the procedure of choice, regardless of the size or position of the lesion. Only if the ulcer is so high in the stomach that a resection is very difficult, or if the patient is so weak as to make radical surgery unjustifiable, should one be content with any other measure. If partial gastrectomy is not possible, the ulcer should be excised whenever feasible, and a posterior gastrojejunostomy done. The latter procedure may be used alone in the case of an inaccessible ulcer or in the weak or old patient.

In doing the partial gastrectomy the resection should extend above the indurated area of the ulcer and in any case far enough above the antrum to remove a considerable portion of the acid secreting mucosa of the stomach. In order to re-establish the gastro-intestinal continuity after removal of a portion of the stomach, Billroth devised two types of operations the Billroth I and the Billroth II. In the former the end of the duo-

denum is connected to the end of the stomach near the greater curvature and the remaining portion of the open end of the stomach is closed. In the Billroth II procedure the open end of the stomach is entirely closed and the jejunum is brought up and anastomosed to the stomach as in a gastrojejunostomy Neither of these two procedures, as Billroth described them is extensively done at the present time, but they have been the basis for modifications that are in common use.

In the Haberer Finney procedure a modification of the Billroth I the open end of the stomach is anastomosed to the side of the duodenum after the stump of the duodenum has been closed. Of the modifications of the Billroth II the most popular are the Polya and the Hofmeister Finsterer. In the Polya operation, the open end of the stump of the stomach is anastomosed to the side of the jejunum, which is brought up either through the transverse mesocolon, or in front of the colon as suggested by Balfour If the anterior anastomosis is done an enteroenterostomy is sometimes performed between the ascending and descending loops of jejunum, with the idea of promoting drainage of the proximal loop but this should not be done if the operation is for ulcer since it interferes with regurgitation of jejunal contents into the stomach. The Hofmeister Finsterer operation is particularly valuable when the resection must extend high on the lesser curvature. It involves diagonal placement of the clamps and partial closure of the severed end of the stomach, starting from the lesser curvature and anastomosis of the remaining opening to the side of the jejunum.

The Billroth I and its modifications require the approximation of the open end of the stomach to the end or side of the duodenum, and this is not always possible without considerable tension. The Polya or the Hofmeister Finsterer modifications of the Billroth II are most generally satisfactory

Pyloric Obstruction

Obstruction at the pylorus may be due to a gastric ulcer with its associated inflammatory induration and spasm, but occasionally after the ulcer has been healed by medical treatment, the contraction of scar tissue may also produce an obstruction. When at operation, an ulcer is found, a partial gastrectomy should be performed. When no ulcer is present, however and the obstruction is found to be due to scar tissue, a posterior gastrojejunostomy will usually be sufficient.

Perforated Ulcer

In dealing with an acute perforated ulcer the main consideration is to save a patient s life The hole in the stomach should be closed as quickly and simply as possible, and reinforced with a tab of omentum, no surgery directed toward the cure or prevention of future ulcers should be done. If the perforation is of the subacute or chronic type, with little

soiling of the general peritoneal cavity, resection of the stomach should be performed unless adhesions are so extensive as to make it impossible in which case one must be content with a gastrojejunostomy, making the stoma on the anterior or posterior surface of the stomach, depending on which is more distant from the lesion.

Bleeding Ulcer

A gastric ulcer that is uncontrollably bleeding always presents a serious surgical problem because the patient is in such poor condition The stomach may be opened to inspect the ulcer, large bleeding vessels may be tied with silk, and cautery may be used on smaller oozing points, but whenever possible partial gastrectomy should be done Excision of the ulcer is the next best procedure

Benign Tumors of the Stomach

Local excision of these lesions should be performed whenever possible. If the lesion is pedunculated and movable a gastrotomy is done on the anterior surface of the stomach, and through this the lesion is excised and the mucous membrane defect is sutured. If the tumor has a broad base and there is any possibility that it may be malignant, a partial gastrectomy is the operation of choice.

Carcinoma and Sarcoma of the Stomach

In the treatment of both of these lesions the stomach should be resected a considerable distance above any palpable area of induration. Evidence of metastasis to the liver dense fixation of the stomach to neighboring organs or metastatic carcinoma elsewhere in the abdominal cavity are contra indications to the operation. In exceptional cases resection of the transverse colon, where extension of the tumor has taken place, and removal of superficial areas of carcinoma on the pancreas may be justifiable, and occasionally a partial gastrectomy may be done for palliation in spite of one or two metastatic nodules apparent in the liver If the lesion is located or extends very high in the stomach, and the position and accessibility of the stomach permit, a total gastrectomy may be done. When pyloric obstruction is present, and because of metastasis or extension of the tumor a radical operation cannot be performed, a gastrojejunostomy may be done and usually the anterior anastomosis is advisable, in which case an anastomosis is made if desired between the ascending and descending loops of jejunum.

Syphilis of the Stomach

If gastric syphilis is encountered, it will probably not be recognized as such and will resemble carcinoma. A frozen section will make the diagnosis clear and eliminate the necessity for partial gastrectomy

TECHNIQUE

Gastrostomy

Only three of the numerous methods of performing this operation will be described. The Stamm method is most commonly used, but where the expected life of the patient is long and the gastrostomy is to be permanent the method of Janeway is most satisfactory

Stamm Method The abdomen is opened through a left upper rectus incision about 5 centimeters long The anterior surface of the stomach at about its middle is grasped with two Allis forceps about 2 cm. apart and drawn into the wound. A pursestring suture of silk or 00 chromic catgut is inserted with a radius of about .5 cm. After the area is packed off an opening is made in the center of the pursestring suture large enough to admit a good-sized catheter with an extra eye cut near the end, into the stomach. The end of the catheter is adjusted so that about 2 5 cm. protrudes into the stomach. The needle of the pursestring suture is passed through the wall of the catheter and the pursestring is pulled tight and tied (Figure 101C) Another pursestring suture is introduced about 1 cm. outside the first one, and as the catheter is pushed inward this suture is tied, thus inverting the first pursestring A third and even a fourth pursestring suture may thus be introduced, depending on the size of the stomach. The catheter is now brought out through the abdominal incision, and the wall of the stomach is attached to the parietal peritoneum by a few interrupted sutures of catgut before the incision is closed. An alternate method is to bring the catheter out through a small stab wound on the left side of the abdominal wall, at a point to which the gastrostomy opening is easily approximated. A single suture of silk or dermal is then inserted in the skin and tied around the catheter to hold it in place for a few days.

Witzel Method The first stage of this procedure is the same as that used in the Stamm method (Figure 101A) A pursestring suture is inserted at a point in the middle of the anterior wall of the stomach, and in the center of this a puncture wound is made and a large catheter inserted. The needle on the end of the pursestring suture is passed through the catheter near its edge, so that when the pursestring is tightened the catheter will be held in place. The catheter is now laid down on the surface of the stomach and, by means of a series of interrupted sutures of chromic catgut, the wall of the stomach is pulled up around the catheter so that it comes to lie in a tunnel for a distance from 3 to 5 cm. (Figure 101B) These sutures are inserted about .5 cm. apart and passed through the serous muscular and submucous coats of the stomach on each side The catheter is then drawn out through the incision, and the stomach anchored in place by a few sutures to the peritoneum, or the

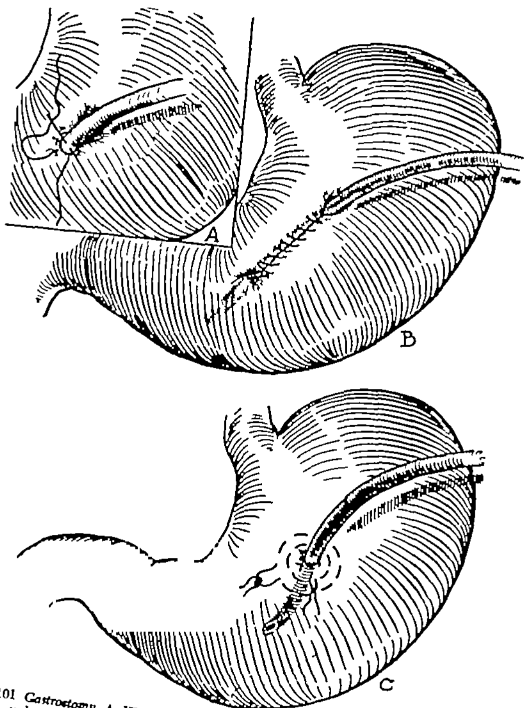


Fig 101 *Gastrostomy* A. *Witzel Method.* A stab wound has been made in the stomach, and a tube is being held in place by a pursestring suture B The tube is pushed back against the stomach wall and the wall is closed over it for a few centimeters by a continuous catgut suture C *Stamm Method.* The tube is introduced into the stomach through a stab wound, and after preliminary fixation by a pursestring suture one bite of which passes through the wall of the tube the tube is progressively inverted into the stomach by two successive pursestring sutures

catheter may be passed out through a stab wound and h
dermal suture There is a tendency for both the Stamm
trostomies *to close* spontaneously so that when the cat
for cleaning or replacement it becomes increasingly diffic
to replace it.



Method of Janeway For a more permanent type of gastrostomy this method is to be recommended. The abdomen is opened through an upper left rectus or midline incision, and an area is selected on the anterior wall of the stomach as high as practicable. At this point a flap 2.5 to 3 cm. wide and 5 or 6 cm. long, consisting of the entire thickness of the stomach, is turned back with the end nearest the greater curvature as the hinge (Figure 102 A and B) This flap is used to make a mucosa lined tube, which will be brought through the abdominal wall and sutured to the skin at its opening The outline of the flap is marked with Allis forceps at appropriate points, the region is packed off to prevent soiling, and an incision is made through the stomach wall with a knife. The gastric contents are aspirated, and the remainder of the cutting is most easily done with scissors. Any bleeding vessels are caught with hemostats and tied with fine catgut. Two Allis forceps are placed on the loose end of the flap and one is placed in the middle of the opening in the stomach at the lesser curvature When tension is made on these, the rectangular opening in the stomach is converted into a roughly linear incision. Starting at the lesser curvature, the mucosa of the stomach is approximated with a continuous suture of 00 chromic catgut, and when the base of the flap is reached a large-caliber catheter is laid on the flap and the mucosa is sutured over it, this process being continued out to the distal end of the flap (Figure 102C) With another similar suture the remaining layers of stomach are united over the mucosa. When this suture reaches the end of the tube, it is tied, passed through the side of the catheter and tied again, thus holding the catheter temporarily in place. A stab wound large enough to admit the gastric tube is now made under the costal margin to the left. A hemostat is passed through this into the abdomen, the end of the catheter is grasped, and the tube is gently drawn out through the abdominal wall. Two or three interrupted sutures of catgut may be used to fasten the outer layers of the tube to the rectus sheath, and the mucosa may be drawn out of the tube a short distance and attached by interrupted sutures to the skin.

Ramstedt Operation

A right rectus or paramedian incision about 4 cm. long is made in the upper abdomen. The left index finger is inserted and hooked over the lesser curvature of the stomach to pull the pylorus into view and the assistant grasps the stomach with moist gauze and holds it in position. An incision is made over the pyloric mass (Figure 103A) extending a little farther onto the duodenum than the stomach, extreme care must be used not to perforate the mucosa of the duodenum, which is very thin. If such an accident occurs, the opening is closed by a few interrupted sutures of 00 chromic catgut. A hemostat is now used to pry apart the margins of the incision so that the mucosa will bulge into view (Figure

103B) Having made sure that all muscular bands have been cut over the mucosa in the region of the stenosis, the abdomen is closed without drainage.

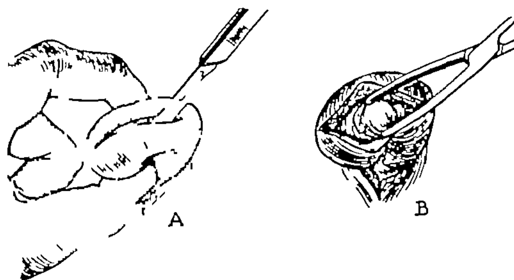


FIG. 103 *Ramstedt Operation*. A. While the pylorus is grasped in the fingers, an incision is made down to the mucosa. B Forceps are used to separate the muscular walls of the incision, allowing the mucosa to bulge through.

Posterior Gastrojejunostomy

The abdomen having been opened through a right rectus or right paramedian incision, the greater omentum is grasped, pulled out of the abdomen, and tension is made so as to bring the stomach into view An Allis forceps is placed on the stomach near the lesser curvature at the angle, that is about in line with the esophagus Another clamp is placed vertically below this near the greater curvature, both clamps being placed far enough in to avoid the large vessels. The clamps should be about four finger breadths apart. The assistant now grasps the greater omentum and holds it up fan wise so that the surgeon can select a bloodless area in the transverse mesocolon for incision. Extreme care must be used to avoid the middle colic vessels an injury to which may cause necrosis of the transverse colon A small opening is made in the transverse mesocolon, and this is enlarged to a length of about 7 cm. with scissors. The left hand of the surgeon is now placed on the anterior surface of the stomach and pushes the stomach down so that its posterior surface presents through the rent in the transverse mesocolon (Figure 104) The Allis forceps, which have been placed on the anterior surface will be felt on the posterior surface and two other Allis forceps are placed on the posterior surface directly opposite them (Figure 105) The first forceps are removed, and the posterior wall of the stomach is pulled partly through the transverse mesocolon. At the root of the transverse mesocolon, the first loop of



FIG 104 *Posterior Gastrojejunostomy* An incision has been made in a bloodless area of the transverse mesocolon, and the posterior wall of the stomach is being pushed through The first loop of jejunum is seen as it appears under the ligament of Treitz

jejunum will be seen as it emerges at the ligament of Treitz This should be grasped and pulled on to be certain that there is no jejunum that lies retroperitoneally There are only two fixed regions in the jejunum and ileum the beginning of the jejunum and the end of the ileum, and it does no harm to bear in mind that the termination of the ileum at the cecum may be no great distance from the beginning of the jejunum and that the

ileum has more than once been mistaken for the jejunum with disastrous results. Two Allis forceps are now placed on the jejunum about four *finger breadths apart and about half way between the mesenteric and* antimesenteric surfaces. While the assistant holds up these two forceps, a straight rubber-covered clamp is applied to the jejunum, with the handle pointing toward the distal loop. The major part of the diameter of the

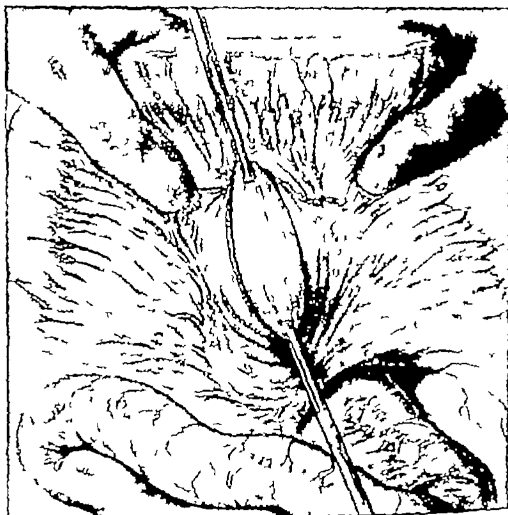


FIG. 105 *Posterior Gastrojejunostomy* Allis forceps have been applied to the posterior wall of the stomach.

jejunum should protrude above the clamp and, when it has been evenly arranged, *the rubber-covered clamp is tightened* and the Allis forceps are removed. Another rubber-covered clamp is now applied to the posterior surface of the stomach, while the assistant holds the two Allis forceps which are in place. The handle of the clamp should point toward the greater curvature of the stomach When enough of the stomach has been pulled through and arranged evenly above the clamp so that the protruding stomach can be easily approximated to the protruding jejunum,

the clamp is tightened and the Allis forceps are removed. Five or six interrupted sutures of chromic catgut are inserted to sew the edge of the transverse mesocolon to the stomach and prevent herniation through the



FIG. 106. *Posterior Gastrojejunostomy* A Doyen clamp has been applied to the posterior wall of the stomach with the handle toward the greater curvature, and another clamp has been applied to the first loop of jejunum with the handle toward the distal loop. The transverse mesocolon is being sutured to the posterior wall of the stomach.

transverse mesocolon (Figure 106) The two Doyen clamps are manipulated so that the handles and ends lie together and a moist sponge to which is attached a hemostat is placed between them. If the jejunum with the clamp thus applied cannot easily be approximated to the clamp on

the stomach, it may be turned in the opposite direction In other words it is not as important to have the distal loop of the jejunum come off the greater curvature as it is to have no kinking or tension on the jejunum The anastomosis should be made as close to the ligament of Treitz as is consistent with this principle. The two clamps are fastened together by inserting a hemostat into the open end of the rubber coverings and locking it. Two moist packs are laid on each side of the field and neatly arranged around the clamps It is convenient to have the handles of the clamps pointing toward the surgeon while the suturing is being done. Starting at the point away from the surgeon and using either a straight or curved intestinal needle on 00 chromic catgut, the outer layers of the stomach are sutured by a Lembert stitch to the outer layers of the jejunum for a distance of four finger breadths (Figure 107) This suture is then locked and with its needle is laid down and covered with a moist pack for future use. With the knife an incision three finger breadths long is made in the jejunum parallel to the suture line. When the knife has penetrated the mucosa at one point, scissors may be used to continue the incision. The assistant meanwhile sponges away any intestinal secretion that may be exuded. A similar incision is made in the stomach, and using another suture of 00 chromic catgut on a straight intestinal needle, and again starting at the point away from the surgeon, the adjacent jejunal and gastric margins of the incisions are approximated (Figure 108) For this suture a running stitch that passes through all the layers is used. When the entire length of the incision has been traversed, the suture is locked and continued around the anterior margins of the opening as a Connell stitch, passing through all the layers of the stomach and all layers of the jejunum (Figure 109) When this suture reaches the starting point it is tied to the original end, which has been left long and marked with a hemostat. Before this layer of sutures is entirely completed, the clamps are loosened, and the inside of the anastomosis is inspected for bleeding vessels. If any are seen they are clamped and tied, if necessary loosening up some of the sutures in order to gain access to the desired points. The suture line having been completed it is sponged off with moist sponges the packs, rubber-covered clamps, and sponge are removed, and the first or serosal suture is continued as a Lembert stitch back to its starting point, where it is tied to its original end (Figure 110) Both sides of the anastomosis are inspected to be sure that there is no protruding mucosa and no bleeding points and as it is dropped back into the abdomen the jejunum is adjusted so that it is not unduly kinked.

The operation as described above provides a vertical stoma in the stomach as advocated by Moynihan (Figure 111) but there is no objection to making a stoma that runs parallel to the long axis of the stomach or diagonal to it.

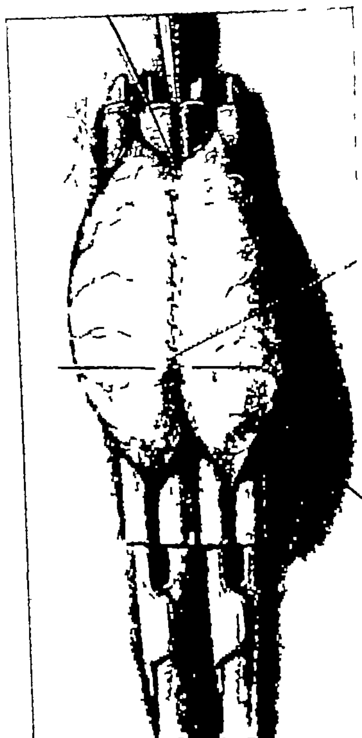


FIG. 107 *Posterior Gastrojejunostomy* The handles of the clamps have been pointed toward the surgeon, and the first or serosal suture layer is being put in. The stomach is on the left.

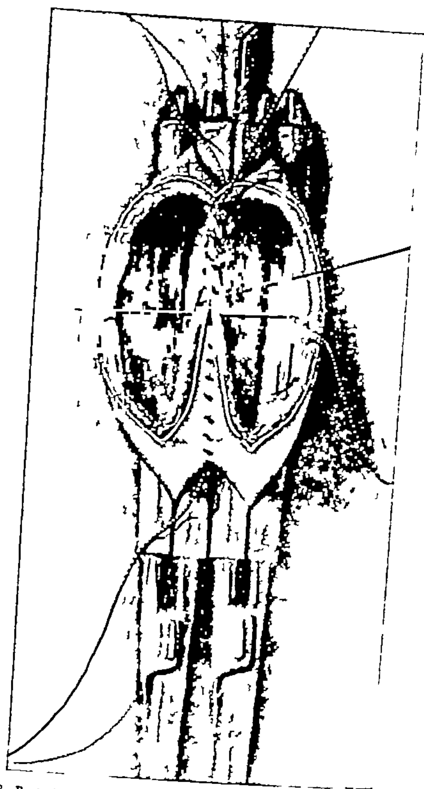


FIG. 108 *Posterior Gastrojejunostomy* The stomach and jejunum have been opened and the second layer of sutures is being inserted. These sutures take in the entire wall of both jejunum and stomach.

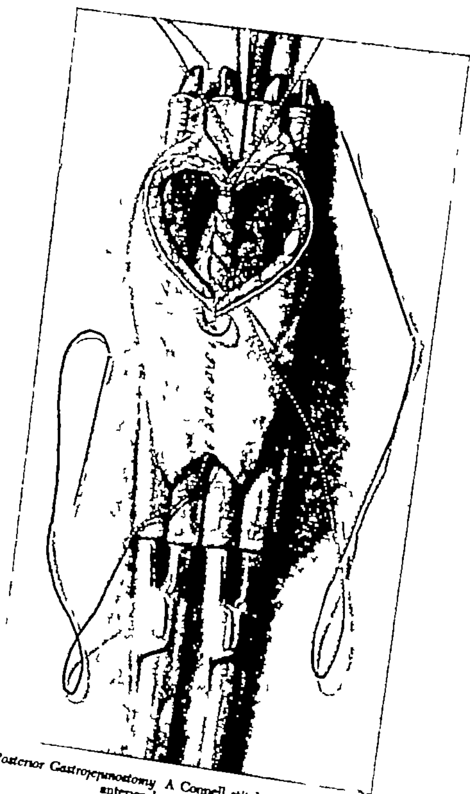


FIG. 109 *Posterior Gastrojejunostomy* A Connell stitch is being used for the first anterior layer of sutures.



Fig. 110 *Posterior Gastrojejunostomy* The clamps have been removed and the serosal layer which was begun posteriorly is being continued around in front to its starting point

Anterior Gastrojejunostomy

Allis forceps four finger breadths apart are applied to the anterior surface of the stomach either parallel to the axis of the esophagus, near the greater curvature or diagonally A Doyen clamp is applied below the Allis forceps with the handle toward the greater curvature or toward the pylorus if the stoma is to be made horizontal. The transverse meso-

colon is held up and the first loop of jejunum is identified. The hand is now moved along the jejunum until a sufficient amount is obtained to pass around the transverse mesocolon and go up to the stomach without producing tension on the transverse colon. When this point is determined,

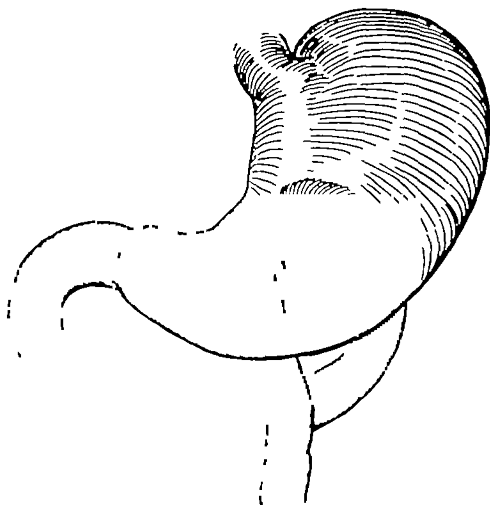


FIG. 111 *Posterior Gastrojejunostomy* Diagrammatic illustration to show the location of the stoma at the completion of the operation.

two Allis forceps are applied four finger breadths apart and a rubber covered clamp with the handle toward the distal loop is put on below them. The Doyen clamps are now brought together and the anastomosis is done as described under posterior gastrojejunostomy (page 324) Because of the long loop of jejunum necessary for this procedure, it may be desirable to make an anastomosis between the jejunum where it starts up to the stomach and the loop of jejunum as it comes down from the stomach. This stoma need only be about 2 cm. in length.

Partial Gastrectomy

Since the removal of the lower end of the stomach is common to all Billroth I and Billroth II operations and their modifications, the technique of removing this portion of the stomach will first be described, and later

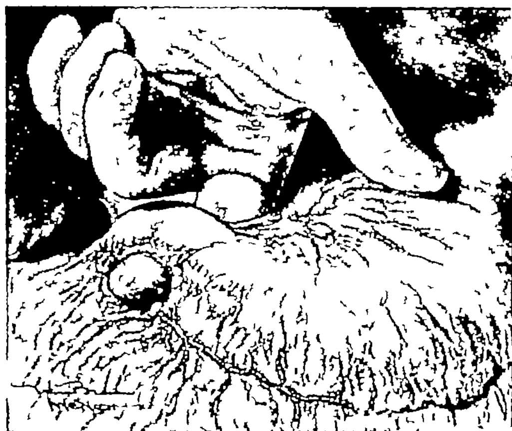


FIG. 112. *Partial Gastrectomy and Posterior Polya Anastomosis.* The right gastric and right gastro-epiploic arteries have been cut and ligated and the pylorus freed.

under the appropriate headings various methods of anastomosis will be explained.

The abdomen is opened through a right rectus or right paramedian incision. The greater omentum is pulled downward to bring the stomach into a position where it can be grasped with moist gauze or an Allis forceps. A small opening is made in the gastrohepatic omentum in a bloodless area just above the pylorus. As soon as this entry has been made two hemostats are applied to the region of the right gastric artery and the omentum is cut between them. The site of the pylorus will be marked by the pyloric vein, which courses across it. The left index finger is inserted through the rent in the gastrohepatic omentum passed downward behind the pylorus and used to lift the pylorus forward. The right gastro-epiploic artery will be seen about 2 cm. below the greater curvature and it should be cut between hemostats (Figure 112) One now has an open

ing behind the pyloric end of the stomach and, after freeing the upper end of the duodenum, two Payr clamps are inserted and the duodenum cut between them (Figure 113) Attention is now directed to the duodenal stump, which is further freed so that it can be dealt with as desired. If a Billroth II procedure is to be used, the duodenum is closed by the



FIG. 113 *Partial Gastrectomy* Payr clamps have been applied and the duodenum has been separated from the stomach.

Parker Kerr basting stitch applied over the clamp (Figure 114) and reinforced by a Lembert suture in the serosa and a tab of omentum. Number 00 chromic catgut may be used on a curved needle· the secret of obtaining good inversion of the stump as the clamp is removed is to put in the stitches .5 cm. or more away from the clamp Attention is now returned to the stomach, if it happens to be distended with fluid, a pursestring suture is put in on the anterior surface and a suction tube is inserted through a puncture wound in the center of it. As the suction tube is withdrawn, the pursestring suture is tied. The index finger is inserted in the opening in the gastrocolic omentum where the right gastro-epiploic artery was cut, the omentum is lifted up and by inserting one blade of a hemostat through the gastrocolic omentum and the other through the

free margin progressive portions of the omentum are severed between clamps, below the line of the epiploic vessels. Care should be taken, when the operation is being done for carcinoma, that any visible or palpable lymph glands along the greater curvature are included in the resection. This process is continued along the greater curvature to a point about 2 cm. above the proposed point of resection, where the left gastro-epiploic artery is clamped and tied. Starting now along the lesser curva-

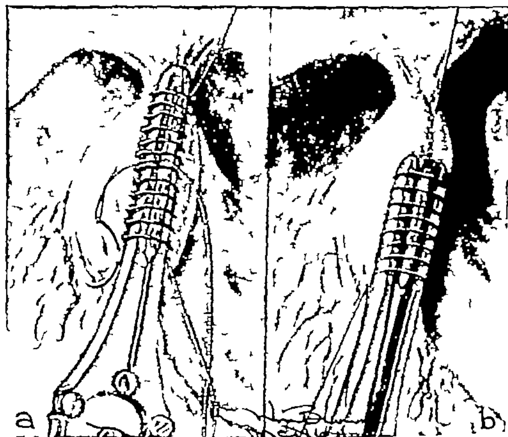


FIG 114 *Partial Gastrectomy* Closure of the duodenal stump.

ture and beginning at the opening in the gastrohepatic omentum, successive portions of this omentum are caught between clamps and cut, until a point about 2 cm. above the proposed site of resection is reached. In a resection for carcinoma, the lesser omentum should be removed as widely as possible, to include the lymph nodes which may be involved. On the lesser curvature above the angle of the stomach, a number of large branches of the left gastric artery run downward almost parallel to the lesser curvature. These are clamped and cut close to the wall of the stomach At the proposed site of resection the stomach wall is thoroughly denuded of omentum on both curvatures for a distance of about 2 cm. and two clamps are applied. The one on the portion to be resected may be a heavy Payr clamp and if the upper end of the stomach is to be

closed, a similar clamp may be applied there but if it is to be anastomosed to the bowel a rubber shod clamp should be used.

When a Polya type of operation is contemplated, there are some advantages in applying one rubber shod clamp just above the point of proposed resection and putting in the first line of sutures, before applying the sec-



FIG 115 *Partial Gastrectomy and Beginning of Posterior Polya Anastomosis.* The first loop of jejunum has been brought through the transverse mesocolon and the first row of sutures has been inserted between it and the stomach.

ond clamp to the distal stump and cutting off the stomach. If one chooses to do so one may use large Payr clamps, cut the stomach off put in the first row of sutures, and then remove the Payr clamp and apply a rubber covered clamp above the suture line. The crushed portion of the stomach wall is then cut off and the operation proceeds as usual. (See also technique of Polya anastomosis.)

The Billroth I Procedure

General Considerations This, the first method of partial gastrectomy and anastomosis devised by Billroth, has been subjected to numerous

modifications the common feature of which is that the end of the stomach is anastomosed to the duodenum. In the original Billroth operation, the end of the duodenum was connected to the end of the stomach near the greater curvature, and the remaining portion of the open end of the stomach was closed in a direction parallel to the long axis of the body To mention two variations of this procedure, the duodenal stump may be connected to the end of the stomach near the lesser curvature or the duodenum may be flared open by making an incision on its anterior surface so that the stoma approximates in size the cut end of the stomach, and end to-end anastomosis performed. The duodenum may also be connected to the stomach near the greater curvature and the remainder of the stomach may be closed in a diagonal direction, after the upper corner is removed at the lesser curvature. Another variation is to connect the end of the stomach to the side of the duodenum after closing the duodenal stump and this, the Haberer Finney modification, will be described. The Billroth I procedures are not in common use because first, they necessitate the approximation of the end of the stomach to the duodenum, which in some cases may be mechanically impossible and not only must these two structures be brought together but they must be brought together without tension. Second, mobilization of the duodenal stump is sometimes difficult and in occasional cases it may be impossible to obtain free duodenum to make an end-to-end anastomosis. Third, this mobilization of the end of the duodenum is sometimes attended with wounding of the gastroduodenal artery and considerable hemorrhage, and must be very skilfully done. Fourth, the small stoma that results is not conducive to free regurgitation of duodenal fluid into the stomach, a factor believed to be of value in reducing gastric acidity Fifth, if a duodenal ulcer occurs after the operation, it is more apt to be in the region of the papilla of Vater since the duodenum is inevitably shortened by the anastomosis.

Technique After the duodenum has been severed, the stomach freed up to the point of resection, doubly clamped and cut off and the surgeon has ascertained that the stump of the stomach can be approximated to the stump of the duodenum without tension the duodenum is very carefully freed distally for at least 2.5 cm. The dissection here should be very close to the duodenal wall, and bleeding from attachments to the pancreas should be carefully clamped and ligated. An opened sponge to which is attached a hemostat is arranged underneath the end of the duodenum, the Doyen clamp on the stomach is approximated to the Payr clamp on the duodenum, and the area is surrounded by moist packs. A portion of the upper end of the opening in the stomach is now closed so that the opening left below will approximate in size that of the lumen of the duodenum. This is most easily done by making a running suture of 00 chromic catgut first in the mucosa of the stomach and second in the outer layers. Temporarily everting the clamp on the stomach makes this

procedure easily done with a straight needle Now using a curved intestinal needle and the same suture material a continuous Lembert stitch unites the outer layers of the posterior surface of the duodenum to the outer layers of the posterior wall of the stomach. When the end at the

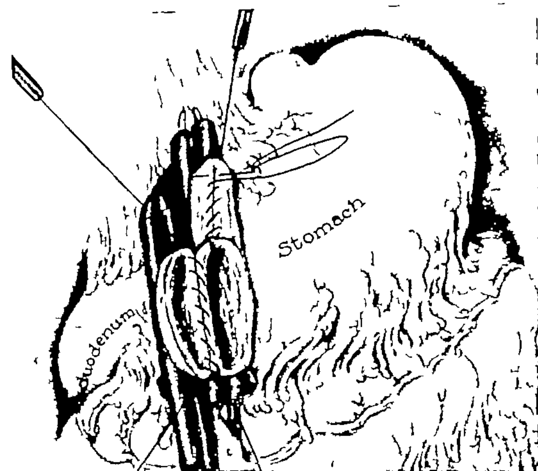


FIG 116. *Partial Gastrectomy with Billroth I Anastomosis.* Part of the open end of the stomach has been closed by two layers of sutures, and the remaining open end of the stomach is being anastomosed to the open end of the duodenum. Two posterior layers of sutures have been inserted.

greater curvature of the stomach is reached, this suture is locked, laid down and covered with a moist pack. The Payr clamp on the duodenum is now removed, and the crushed portion is cut off with scissors so that the lumen opens. By suction and sponging, the duodenal contents are removed as they appear A continuous running suture, starting away from the surgeon, unites all the layers of the posterior wall of the duodenum to all of the layers of the posterior wall of the stomach (Figure 116) When the angle is reached, the suture is locked and continued around the anterior surface, a Connell stitch uniting the anterior surface of the stomach to the anterior surface of the duodenum. The moist pack that covered the first suture is now removed, and this is continued back to its

starting point as a Lembert suture through the outer layers of stomach and duodenum. A piece of omentum may be brought up over the anastomosis and held in place by the serosal suture as it is tied.

Haberer Finney Modification of Billroth I The duodenal stump after being mobilized as described above, is closed by means of 00 chromic

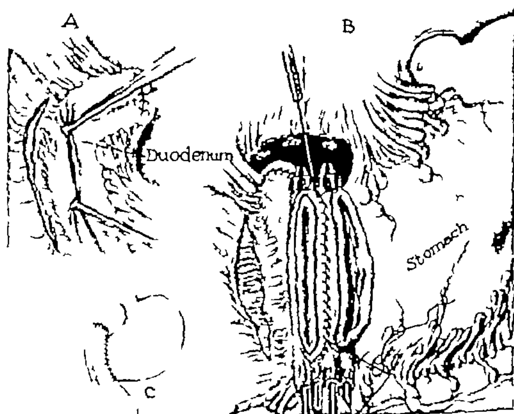


FIG 117 *Partial Gastrectomy with Haberer Finney Anastomosis.* A. The duodenal stump has been closed and the peritoneum on the lateral side of the duodenum has been incised so that the duodenum can be rolled over medially B The side of the duodenum is being anastomosed to the proximal stump of the stomach The first posterior layer of sutures has been inserted. C. Diagrammatic illustration of the completed operation

catgut on a curved intestinal needle. This suture is first passed through the upper angle of the duodenum underneath the Payr clamp and held by a hemostat. It then crosses the Payr clamp and enters the outer layers of the duodenum. Returning from this point, it crosses the Payr clamp and takes a similar bite in the duodenal wall on the other side. This process is continued across the duodenal stump with the sutures about 4 mm. apart. The assistant now grasps the hemostat that held the end of the suture and while he pulls on this the surgeon pulls on the other end, and the Payr clamp is slowly removed, thus inverting the duodenal stump The same suture is continued back to its starting point and tied to the hemostat held end. If desired, four or five interrupted Lembert or Halsted

sutures of silk or chromic catgut may be inserted further to reinforce the stump The peritoneum along the lateral surface of the second part of the duodenum is cut (Figure 117A) and the duodenum is rolled over medially If possible a rubber-covered clamp is applied to this portion of the duodenum parallel to its long axis and approximated to the Doyen clamp on the stump of the stomach. A sponge is placed behind and between the clamps and a pack is arranged on each side. If a clamp cannot be applied to the duodenum, it may be held taut with Allis forceps or a stay suture on each end, until the serosal layer of sutures between the posterior surface of the stomach and the medial edge of the duodenum is completed (Figure 117B) An incision that approximates in size the stoma of the cut end of the stomach is now made through the anterior duodenal wall, and a running suture, starting away from the surgeon unites all the layers of one side of the duodenal stoma to the adjacent layers of gastric stoma. The suture is locked when it reaches the angle nearest the surgeon, and continued around the anterior surface as a Connell stitch, being tied when it reaches its starting point to the original end. The clamps are removed and the serosal suture is picked up and continued around the anterior surface back to its starting point (Figure 117C)

The Billroth II Procedure

General Considerations This operation as devised by Billroth consisted of closing the stump of the stomach and making a gastrojejunostomy but it has since been subjected to numerous modifications. The classical Billroth II is now rarely done because with the extensive resections of the stomach now practiced, it is more difficult to connect the jejunum to the stump of the stomach at the side than it is at the end, and in the latter case the opening already present in the stomach can be utilized. This method, the Polya modification of the Billroth II is more quickly and simply done since the stump of the stomach need not be closed. The wide stoma it provides may cause rapid emptying of the stomach, but is desirable because of the free regurgitation of duodenal contents into the stomach which it permits. When a very high resection has been done, however it may be difficult to connect the jejunum to the upper part of the opening in the stomach, and the operation may be facilitated by closing the upper part of the stump of the stomach and anastomosing only the lower part to the jejunum. This is the Hofmeister Finsterer modification of the Polya.

Technique The stomach is cut off just below the pylorus, and the duodenal stump is closed as previously described. The lesser and greater curvatures of the stomach are freed (see Partial Gastrectomy) and two Payr or rubber-shod clamps are applied to the stomach about 2 cm. apart at the point chosen for resection. The stomach is severed near the uppermost Payr clamp or if a rubber-covered clamp is used, about 1 cm. below

it. In the latter case the stump of the stomach is most conveniently closed by using first a running suture of 00 chromic catgut, starting at the upper angle and passing through the mucosa only This is tied and a new running suture is used to approximate the outer layers of stomach over the mucosa. This may be further reinforced with a Lembert suture of the same material. Before the serosa is closed over the mucosa, the rubber covered clamp is loosened to be sure that no bleeding vessels are present. If any are spurting they are caught and tied. In the case of the Payr clamp a chromic catgut suture is started at the upper angle but passes back and forth through all the layers of the stomach just proximal to the Payr clamp. When this suture reaches the greater curvature it is tied, the clamp is removed, the crushed portion of the stomach is cut off and the suture is continued back to its starting point by the Lembert method. A third reinforcing Lembert suture may also be inserted if desired. The transverse mesocolon is now held up fan wise and the first loop of the jejunum is located and picked up with two Allis forceps. A bloodless area is selected in the transverse mesocolon and an opening made through it. If the stump of the stomach can be brought down through this opening, it is pulled down by Allis forceps and held while a rubber-covered clamp is applied to the posterior surface of the stomach in any convenient bloodless area. If the gastric stump is not long enough to come down, the jejunal lóop is brought up through the opening in the transverse mesocolon, a Doyen clamp is applied to it, a similar clamp is applied to the posterior surface of the stomach, and a gastro-enterostomy is made as has been previously described (page 324) The stoma may point either in the long axis of the body or transversely but should be as near to the greater curvature as the large vessels permit. The direction of the jejunal loop is not of a great deal of importance but the distal loop should be approximated to the greater curvature or point toward the pylorus, if no kinking or tension is thus produced. If the stomach can be pulled down sufficiently now to suture it to the opening in the transverse mesocolon, this is done by a few interrupted sutures if not, the rent in the mesocolon is closed snugly but not tightly around the jejunal loop and a few sutures may be made between the jejunum and the transverse mesocolon if desired.

Polya Anastomosis

The stomach is cut off just below the pylorus, the duodenal stump is closed, and the area of the stomach to be resected is freed (see Partial Gastrectomy) A Doyen clamp is applied just above the point of resection with the handle toward the greater curvature. By lifting up the transverse mesocolon, the beginning of the jejunum is located just below the ligament of Treitz and marked with an Allis forceps. An opening is made through the transverse mesocolon in a bloodless area, and the jejunal

loop is pulled up through this and held, while a Doyen clamp is applied to it with the handle toward the distal loop A sponge with a hemostat attached to it is now laid between the two clamps the area is packed off with moist packs, and using 00 chromic catgut on a curved intestinal

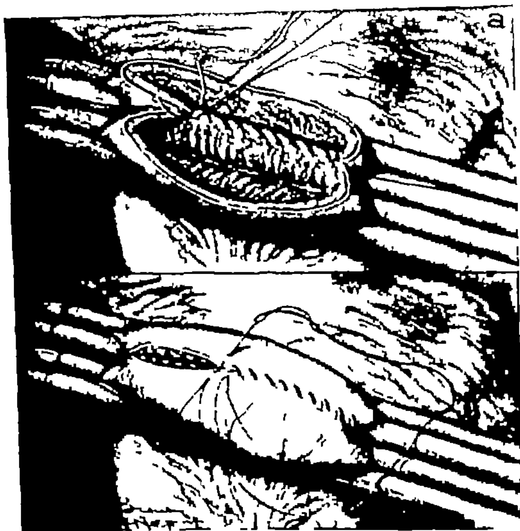


FIG. 118 *Partial Gastrectomy and Posterior Polya Anastomosis.* A. The pyloric end of the stomach has been removed, an incision has been made in the jejunum, and the second posterior row of sutures is being inserted B Second anterior row of sutures is being inserted. (See also Fig. 115)

needle and starting at the lesser curvature, the outer layers of the stomach are approximated to the outer layers of the jejunum by means of a running stitch (Figure 115) When this suture reaches the greater curvature, it is locked and laid down to be covered with a moist pack. A Doyen or Payr clamp is now applied to the stomach about 2 cm. distal to the suture line, and the stomach is cut off An opening is made in the jejunum somewhat smaller than the opening of the stomach, and the jejunal contents are removed by suction or sponging as they appear The incision in the



FIG. 119 *Partial Gastrectomy and Posterior Polya Anastomosis* The anastomosis has been pulled down through the transverse mesocolon, and the transverse mesocolon is being attached to the stomach.

jejunum is best started with a knife and then continued with scissors Number 00 chromic catgut suture on a straight needle is now used to sew all the layers of the *stomach* to all the layers of the jejunum on the posterior surface (Figure 118A) When this suture reaches the greater curvature, it is locked and continued back as a Connell stitch, uniting all the layers of the anterior surface of the stomach to all the layers of the

anterior surface of the jejunum. Before this suture is completed, the clamps are loosened somewhat and the suture line is inspected for bleeding points. If any of these are seen they are caught and tied. The Connell suture is continued back to the lesser curvature, where it is tied to the original end of the suture. The clamps are removed and the original seroserosal stitch is continued around the front of the stomach and jejunum back to its starting point, where it is tied (Figure 118B) A third Lembert suture of 00 chromic catgut may be introduced for additional safety if desired. The stomach is pulled down and sutured to the rent in the transverse mesocolon if possible (Figure 119) If the stump is too short for this maneuver the mesocolon is sutured snugly around the ascending and descending loops of jejunum and a few interrupted sutures of catgut may be inserted between the jejunum and the transverse mesocolon.

Polya Balfour Operation

This is a modification of the Polya procedure in which the jejunum, instead of being brought through the transverse mesocolon, is brought

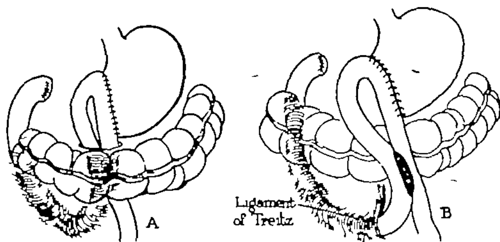


FIG. 120 *Diagram of the Two Types of Polya Anastomosis.* A. Posterior Polya. B Polya Balfour or anterior Polya.

around the colon in front, as in an anterior gastrojejunostomy (Figure 120B) This operation is often more easily performed than the posterior type of anastomosis, and is used rather often in the treatment of carcinoma. A jejunojejunostomy is desirable between the ascending and descending loops of jejunum where they cross the colon.

Hofmeister Finsterer Operation

This operation is performed exactly the same as the Polya procedure except that the resection may extend very high on the lesser curvature, and, before the anastomosis between the jejunum and stomach is begun a

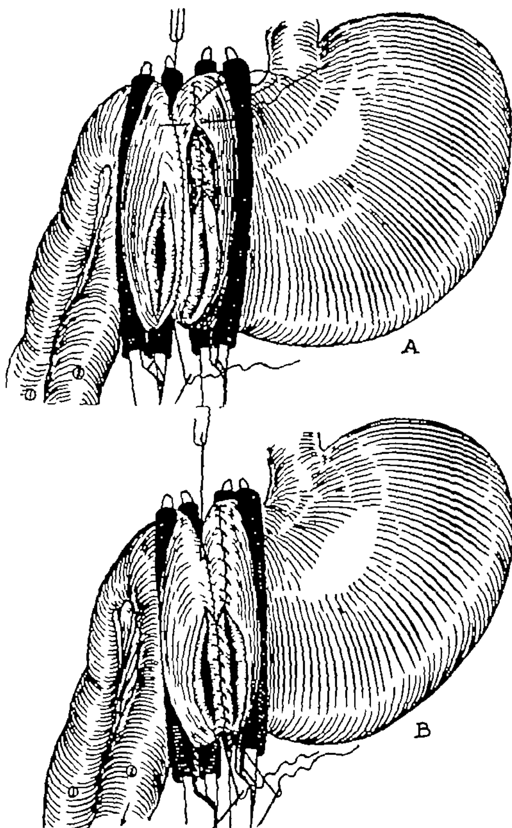


Fig 121 *Partial Gastrectomy with Hofmeister Finsterer Anastomosis.* A. The upper portion of the open end of the stomach is being closed. The first layer of sutures between stomach and jejunum has been inserted. B The second posterior layer of sutures between stomach and jejunum has been completed.

portion of the upper part of the gastric opening is closed by means of a running suture first through the mucosa and then through the outer layers of the stomach (Figure 121) A stoma at least three finger breadths in width should be left, and the opening in the jejunum should correspond to it.

Total Gastrectomy

In rare instances, extensive carcinoma of the stomach without metastasis may be encountered and total gastrectomy is indicated. A left paramedian incision is made, or a right paramedian incision may be extended to the left across the midline. The operation is begun the same as a partial gastrectomy after severing the stomach just below the pylorus, the duodenal stump is closed and the ligation of vessels along the lesser and greater curvature is continued up to the point of entrance of the esophagus. To increase exposure, the left lateral ligament of the liver is cut and the liver is pulled to the right. The stomach is wrapped in a gauze pack and, while making gentle downward traction, a finger is inserted into the esophageal hiatus of the diaphragm and the esophagus is gently freed from its attachments and usually can be pulled down several centimeters to give additional room for the anastomosis Both vagus nerves can easily be identified, and cutting them aids in releasing the esophagus. A length of the first loop of jejunum is brought up through the transverse mesocolon, or in front of the transverse colon, and, while the stomach is used as a tractor on the esophagus, two stay sutures of silk are inserted to approximate the side of the jejunum to the posterior surface of the esophagus. It is essential that this anastomosis be made at a point in the jejunum that can be brought up without tension, as there is always considerable danger of leakage at the suture line. A series of interrupted sutures of similar material is inserted between the stay sutures to complete the first posterior suture line (Figure 122A) The area is packed off as well as possible, and an opening about 2 cm. long is made parallel to the jejunal axis in front of the suture line. While suction is continuously being used, the posterior surface of the esophagus is cut through, and is united by interrupted sutures of silk to all the layers of the posterior surface of the jejunal stoma (Figure 122B) Only after this line of sutures has been inserted is the stomach severed from the esophagus. With the aid of Allis forceps to pull down the anterior surface of the esophageal wall, similar interrupted sutures of silk are used to unite the anterior wall of the esophagus to the anterior part of the jejunal stoma, and this layer is reinforced with similar sutures between the outer layer of the esophagus and the outer layers of the jejunum Several interrupted sutures are now inserted to attach the jejunum to the diaphragm on each side of the anastomosis, to relieve the strain on the suture line. An entero-anastomosis is made between the ascending and descending

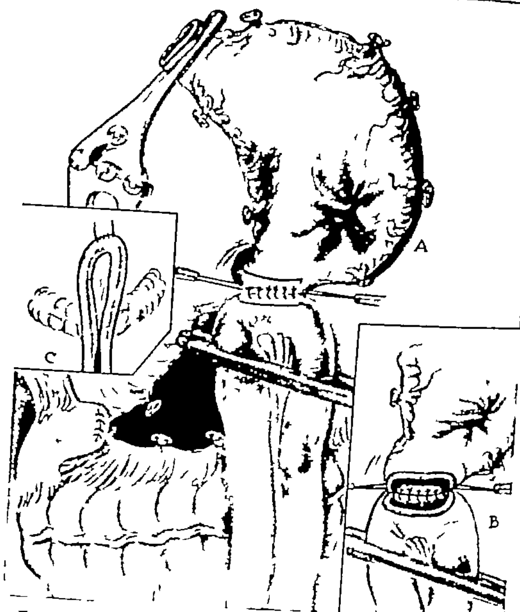


FIG 122 *Total Gastrectomy* A The jejunum has been approximated to the lower end of the esophagus, which is held by stay sutures The first layer of sutures has been placed between esophagus and jejunum B The second posterior layer of sutures has been inserted. C. Diagram of esophagojejunal anastomosis An entero-enterostomy is shown between the ascending and descending loops of jejunum.

loops of jejunum, and, when this is completed, a Levine tube is passed down the esophagus and into the descending loop The tube is to be used for aspiration and after forty-eight hours may be used for feeding

The transthoracic method of total gastrectomy has considerable technical advantage over the abdominal approach. It is described in the chapter on The Mediastinum and Heart.

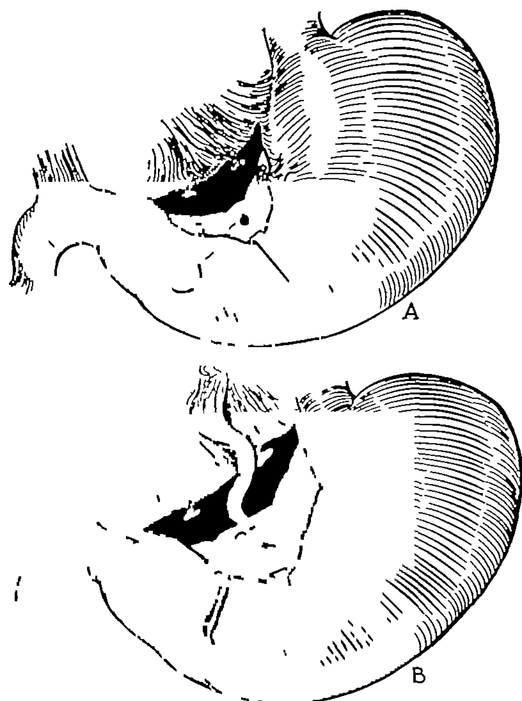


Fig 123 *Treatment of Lesion of the Posterior Wall of the Stomach near the Lesser Curvature.* A. The lesser omentum has been separated from the lesser curvature, and by means of an Allis forceps the posterior surface of the stomach has been turned forward so that a perforated ulcer can be closed by several interrupted sutures B The same method of exposure is used to excise an ulcer with the cautery Following the excision, the opening in the stomach will be closed by two layers of sutures and the lesser omentum reattached to the stomach.

Closure of Perforated Gastric Ulcer

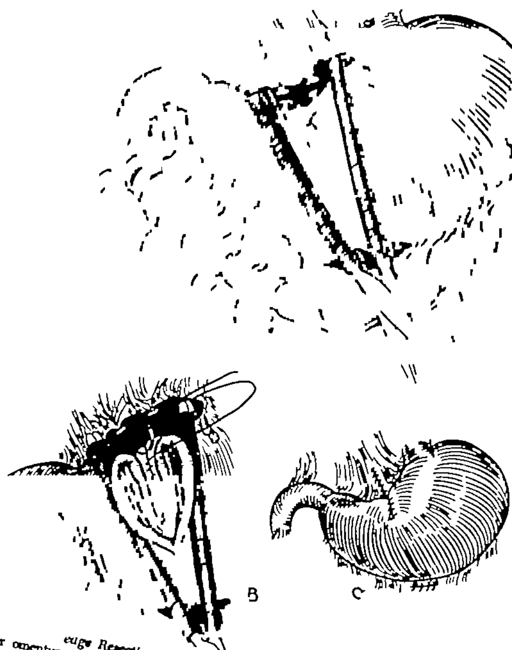
This operation should not be combined with any procedure designed to prevent the future formation of ulcer except in very rare instances. With through-and through interrupted sutures of silk or catgut and a curved intestinal needle the opening is closed, if this can be done without too much tension (Figure 123A) The needle should be inserted beyond the indurated area if possible. If the opening cannot be thus closed, a tab of omentum is pulled up and held in place by the sutures as a patch, and in any case the omentum is used to reinforce the suture line. Care should be used not to pull the sutures so tight as to strangulate the omentum. A common practice is to leave in one or two Penrose drains, but this is usually not necessary Gastric contents present in the peritoneal cavity are removed by suction before the wound is closed.

Wedge Resection of Gastric Ulcer

The gastrohepatic omentum is freed from the lesser curvature of the stomach in the area of the ulcer by first making an opening in the gastrohepatic omentum and ligating the right gastric artery above and below the point of resection. The omentum is cleared from the stomach to a point about 2 cm. above and below the area to be resected. By making two openings in the gastrocolic omentum, two Doyen clamps are now placed across the stomach above and below the area (Figure 124A) and the wedge containing the ulcer is excised, first on the anterior surface of the stomach and then on the posterior surface. By using a curved intestinal needle and 00 chromic catgut, the serosal surfaces of the two posterior sides of the wedge are now united up to the lesser curvature (Figure 124B) At this point the suture is locked and another similar suture is used to make a running stitch through all the layers of the posterior wall of the two sides of the wedge. The mucosa of the two sides of the anterior wall of the wedge is sutured in a similar manner and the serosal stitch is continued around the anterior surface and tied. Two or three interrupted sutures may be put in to reinforce the suture line, and the rent in the gastrohepatic omentum is closed (Figure 124C)

Disconnection of Gastrojejunostomy

This is most commonly indicated for jejunal ulcer and its associated complication gastrojejunal-colic fistula. If the colon is not involved, the stomach may be approached by grasping the greater omentum and spreading it fan-wise, and incising through a bloodless area in the transverse mesocolon. After the mesocolon has been liberated from the stomach, the stomach may be drawn downward to expose the area of the anastomosis. If necessary an incision may be made through the gastrocolic ligament to aid in this dissection. Great care must be used not to



euge Resection of Stomach A Openings have been made in the lesser omentum and the gastrocolic ligament, and two rubber-covered forceps have been applied to the stomach. The dotted line shows the proposed incision. B After excision of the wedge, the first posterior line of sutures is being inserted. C. The openings in the gastrohepatic omentum and the gastrocolic ligament have been closed and the operation completed.

large branches of the middle colic artery as this may result in gan-
e of the transverse colon. The separation should be begun on the
rior surface of the stoma and, a clear area once obtained, should be
wed around, always staying close to the wall of the stomach or
num. After the anastomosis has been entirely freed, it should be lifted
nd a Doyen clamp applied to the loop of jejunum involved and to the
nach. An incision is now made with a knife in the stomach wall just
e the anastomosis and, having penetrated the wall separation is con-
ed with scissors so that the jejunal loop will have, when it is freed,
nall cuff of stomach wall attached to it. All this gastric tissue is now
oved, and with it the ulcer in the jejunum should be excised. Such
lcer is usually located just on the jejunal side of the stoma. The open-
n the stomach is now closed, using the Connell suture of 00 chromic
ut reinforced by a running serosal stitch of the same material. Even
gh a partial gastrectomy may be contemplated at this time, it is bet
o close the opening in the jejunum and select another point for the
tomosis because, unless the gastrojejunostomy was made with a
er jejunal loop than is customary the stoma cannot be approximated
he stump of the stomach without undue tension. The single Doyen
p is now removed from the jejunum and replaced with two similar
ps, one on each limb of the jejunum. The opening in the jejunum is
ped on each side with Allis forceps and pulled laterally thus convert
a longitudinal incision to one that runs crosswise to the bowel. This
osed by the method described for the opening in the stomach. If there
o much loss of jejunal tissue after the ulcer has been excised, it may
impler to resect that portion of the jejunum and make an end-to-end
ide-to-side anastomosis. This maneuver is also sometimes necessitated
the presence of the jejunal ulcer near the mesenteric border of the
el. If the colon is involved in the inflammatory process, or a gastro-
no-colic fistula is present, the area should be very carefully packed off
re the dissection is begun. With the wall of the colon as a guide, and
he use of sharp and blunt dissection, the dissection is continued un-
ither the colon is separated from the mass or a fistula is discovered.
fistula is present, it is quickly severed from the jejunum, the edges of
opening grasped with Allis forceps and the opening in the colon
ed with a continuous suture of silk through all layers of the bowel.
s is reinforced with interrupted sutures of the same material. Only
rarely is it necessary to resect a portion of the colon The opening
in the jejunum by removal of the colon has been temporarily closed
the application of a Doyen clamp and the dissection is continued
lescribed above. When the colon is involved by a fistula and it is im-
ible to close the opening, clamps may be applied above and below the
olved segment, the walls of the colon united for a distance of 7 or 8 cm.
a continuous double row of catgut sutures, and the clamps and bowel

brought out of the wound as is described under resection of the col (page 442) The two limbs of the colon will later be united by the pressu of a clamp The colon is brought out at the lower angle of the abdomi incision.

POSTOPERATIVE CARE

After a Ramstedt operation on a baby small dilute feedings may started as soon as nausea has subsided. Over a period of two days t feedings are gradually increased until at the end of that time, the ch is on a normal schedule. Inadequate fluid intake is corrected by the a ministration of fluids parenterally After other operations on the stoma nothing is given by mouth for forty-eight hours, but during this ti intravenous glucose, saline, and protein hydrolysates are administered, inforced as indicated by whole-blood transfusions. On the third d water is given by mouth in small amounts every hour, and the fluid inta is kept up to normal by the intravenous route On the fourth day, otl liquids in larger amounts are permitted, and at the end of a week t patient is on a semi-soft diet. During the first three days the stoma is kept empty by continuous suction drainage. This is discontinued o when it can be turned off on alternate hours without evidence of gast retention. After total gastrectomy feedings may be started by way the jejunal tube in twenty four hours. Dilute sugar solution is given the drip method, but suction should be instituted from time to time be sure that distention of the jejunum does not occur Enemata and t colon tube are used as indicated to combat distention. Vitamins, incl ing vitamin K if there is any tendency to hemorrhage, are given, a penicillin should be administered particularly when there has been soil of the peritoneal cavity Breathing exercises and frequent change of p sition are helpful in preventing atelectasis and thrombosis. For seve months after an extensive resection of the stomach, the patient sho take small meals at frequent intervals. If there is secondary anemia, i should be given.

CHAPTER XVII

The Duodenum

PREOPERATIVE TREATMENT
INCISION
EXPLORATION
LESIONS OF THE DUODENUM
- Congenital Abnormalities
- Diverticulum
- Duodenal Ileus
- Foreign Bodies
- Benign Tumors
- Malignant Tumors
- Duodenitis
- Duodenal Ulcer
- Perforated Duodenal Ulcer
- Pyloric Obstruction
- Hemorrhage

TREATMENT
- Congenital Abnormalities
- Foreign Bodies
- Diverticulum
- Duodenal Ileus
- Duodenitis
- Benign Tumors
- Malignant Tumors
- Duodenal Ulcer
- Vagotomy
- Perforated Duodenal Ulcer
- Bleeding Ulcer

TECHNIQUE
- Jaboulay's Pyloroplasty

Finney Pyloroplasty
Gastroduodenostomy
Excision of Diverticulum
Subdiaphragmatic Vagotomy

POSTOPERATIVE CARE

The Duodenum

A number of different lesions are seen in the duodenum but the only common one is peptic ulcer. Surgery of the duodenum has a definitely circumscribed but important place in treatment.

PREOPERATIVE TREATMENT

The preoperative preparation for an operation on the duodenum is essentially the same as for an operation on the stomach.

INCISION

Exposure of the duodenum is most satisfactorily secured through a right paramedian or right rectus incision, but, particularly when an extensive resection is contemplated, a transverse incision has definite advantages.

EXPLORATION

A wide bladed retractor is inserted in the right upper edge of the incision and the greater omentum is grasped and tension made on it. This will pull down the stomach, which can be grasped with Allis forceps and further traction will bring the duodenum into view. The first or superior part of the duodenum, about 5 cm. long, begins at the pyloric sphincter which is marked by the pyloric vein, runs upward, backward, and to the right, to end near the neck of the gallbladder. With exception of a small area on the posterior surface near its termination, this part of the duodenum is entirely covered by peritoneum and is the most movable portion. Part of the lesser omentum, the hepaticoduodenal ligament, is attached to the upper border of the first half of this part of the duodenum and the greater omentum is attached to a similar area below. The gastroduodenal artery, the common bile duct, and the portal vein run behind this part of the duodenum, below it lie the head and neck of the pancreas. The second, or descending, part of the duodenum, from 8 to 10 cm. long, passes downward along the right side of the vertebral column to the level of the upper border of the fourth lumbar vertebra. The transverse colon

passes across the middle of this part of the duodenum and is connected to it by a small amount of connective tissue. Below the area where the colon is attached, peritoneum covers the anterior surface of the duodenum. The head of the pancreas and the common bile duct lie on the medial side, which is perforated obliquely by the common-bile duct and pancreatic duct to form the ampulla of Vater An accessory pancreatic duct sometimes enters this part of the duodenum about 2 cm. higher The third or horizontal, portion passes horizontally from right to left and ends just in front of the abdominal aorta, where it starts upward as the ascending portion, which in turn ends at the ligament of Treitz in the duodenojejunal flexure The head and neck of the pancreas lie above the horizontal and to the right of the ascending portion of the duodenum, and the superior mesenteric vessels pass in front of the horizontal portion. The blood supply of the duodenum is from the superior pancreaticoduodenal branch of the gastroduodenal artery which passes along the posterior aspect in the groove between the pancreas and the duodenum. The inferior pancreaticoduodenal branch of the superior mesenteric artery anastomoses with the gastroduodenal artery in the region of the horizontal portion. The anterior surface of the duodenum can be easily inspected down to the point where it is crossed by the transverse colon. To inspect the anterior surface of the horizontal and ascending portion, an incision must be made through the gastrocolic ligament. The posterior surface of the first part may be slightly rotated up or down, and a limited view obtained after an incision has been made in the hepaticoduodenal or duodenocolic ligaments. The peritoneum along the descending portion may be incised and, by grasping the duodenum with Allis forceps, it may be turned inward to inspect the posterior surface of this region. Similarly an incision of peritoneum above or below the horizontal or ascending portion will allow a certain amount of rotation of these parts of the bowel. The posterior wall of the duodenum in the first two parts may be palpated through the anterior wall by a finger on the anterior surface By placing a finger in the foramen of Winslow one may also feel the horizontal portion for a short distance. Lesions of the head of the pancreas or the termination of the common-bile duct may be palpated with one finger in the foramen of Winslow and the thumb on top of the inner side of the descending part.

Because of the common association of ulcer of the duodenum with ulcer of the stomach, the stomach is also thoroughly inspected and palpated. The size of the spleen is determined, and the hand passes down the right side and grasps the ascending colon. This usually can be brought up into the wound far enough to expose the appendix The pelvic organs and the remainder of the colon should now be examined, and the hand passes up-

ward over the kidneys. If other lesions are found in the abdomen besides that in the duodenum one must determine the magnitude of the procedure contemplated on the duodenum before deciding whether any incidental findings should be remedied at the same time. As a rule except for simple appendectomy no other operation should be performed unless the condition found is sufficiently important to demand the postponement of the surgery for ulcer

LESIONS OF THE DUODENUM

Congenital Abnormalities

Rarely stenosis or atresia of the duodenum may be found in the new born. Also, very infrequently variations in the course of the duodenum may be seen, sometimes associated with a persistent mesentery

Diverticulum

An out pouching of the duodenum is occasionally noted, most commonly in the descending portion on the pancreatic side These diverticula may vary considerably in size and the neck may be narrow or wide. The small pouches with wide necks are usually asymptomatic, but the long ones (over 2 cm.) which empty with difficulty, may require removal.

Duodenal Ileus

Associated usually with some congenital abnormality in the development of this part of the bowel, or as a result supposedly of pressure by the superior mesenteric vessels, or even without any evident cause chronic or acute stasis of the duodenal contents with dilatation of the duodenum may occur The acute cases with the symptoms of high intestinal obstruction require immediate surgical attention.

Foreign Bodies

Nails, needles, fish bones buttons, et cetera may pass through the stomach and become lodged in the duodenum. Balls of round worms have also been known to cause complete obstruction of the bowel in this region. Palpation of the duodenum will easily reveal the presence of a foreign body in the lumen.

Benign Tumors

Polypoid adenoma and lipoma may be found in the duodenum, but they are very unusual. They may bleed or cause obstruction.

Malignant Tumors

Carcinoma and sarcoma of the duodenum proper are both rare, but carcinoma of the papilla of Vater is not infrequently seen. A mass is

usually palpable in the descending part of the duodenum, and there is obstruction of the bile duct with jaundice and usually dilatation of the gallbladder The tumor may metastasize to neighboring glands or the liver and with extension it becomes fixed to the pancreas.

Duodenitis

Chronic inflammatory changes in the duodenum, usually the first portion associated sometimes with hypertrophy of the duodenal mucosa, have been termed duodenitis. Associated with this evidence of narrowing of the pyloric sphincter may occasionally be seen.

Duodenal Ulcer

Peptic ulcer is from seven to ten times as common in the duodenum as it is in the stomach. The ulcers may be single or multiple, and are usually located proximal to the papilla of Vater that is, in the first 5 cm. of the duodenum, the most common site is the first portion. There may be extensive adhesions between the duodenum in the region of the ulcer and the gallbladder liver or omentum. When the ulcer is located on the posterior surface there tends to be dense fixation to the pancreas. The crater of a duodenal ulcer is commonly no more than 2 mm. in diameter but it is surrounded by an indurated area that may be as wide as 2 cm. There is usually no difficulty in identifying an ulcer on the anterior surface of the duodenum. Radiating scars are often seen sometimes with gross deformity of the duodenum, and manipulation of the duodenum or gentle rubbing with gauze brings out punctate hemorrhagic spots, which indicate the location of an ulcer within. An ulcer on the posterior surface may be palpable through the anterior wall, but occasionally it may be necessary to incise the anterior wall of the duodenum and inspect the posterior surface to be sure an ulcer is present. An ulcer on the posterior surface may be located near the papilla of Vater and cause obstruction to the outflow of bile but this is fortunately rare

Perforated Duodenal Ulcer

When the perforation is located, as it usually is, on the anterior surface of the first part of the duodenum the opening is seldom walled off and bile, duodenal fluid, and food are found in the abdominal cavity Perforation of a lesion on the posterior wall is commonly blocked by the pancreas and only an area of induration may be palpated.

Pyloric Obstruction

Due usually to spasm but sometimes to scar tissue obstruction at the pyloric sphincter may take place. In these cases there may be a gross deformity of the duodenum. By pressing in with the finger the narrowing can be confirmed.

Hemorrhage

Bleeding may take place from the base of an ulcer and even erosion of the superior pancreaticoduodenal artery may occur The presence of blood will often be evident in the jejunum and ileum.

TREATMENT

Congenital Abnormalities

Abnormalities of the duodenum, unless they cause obstruction are usually found only incidentally in the course of an operation for something else. A duodenojejunostomy should be done to relieve the obstruction if possible, and if not a gastrojejunostomy must be performed. It is rarely worthwhile to try to fix the duodenum in its normal position.

Foreign Bodies

When a foreign object is located in the duodenum, if possible it should be pushed upward to the second portion, where it will be readily accessible through an incision in the anterior wall. If it is fixed in the horizontal or ascending parts, it may be approached through the gastrocolic ligament and an incision made through the bowel over the object, after which the opening is closed in a transverse direction so as not to narrow the lumen.

Diverticulum

Unless the diverticulum is large or has a narrow neck or has been producing symptoms, operation is usually unnecessary A duodenal diverticulum may be very difficult to locate at operation even though it is known to be present. Frequently the sac is embedded in the pancreas and it may be necessary to dissect the gland away from the bowel. If the diverticulum cannot be found in this way a longitudinal incision should be made in the second part of the duodenum and the mouth of the sac located in the bowel. The neck of the diverticulum is doubly clamped and cut, the opening in the duodenum being closed in a transverse manner by two layers of sutures.

Duodenal Ileus

If the cause of the obstruction cannot be found and eliminated, posterior gastrojejunostomy should be performed.

Duodenitis

If there are obstructing symptoms pyloroplasty may be done Gastrojejunostomy or the more radical partial gastrectomy may be indicated in some cases.

Benign Tumors

When one of these is identified in the lumen of the duodenum, an incision is made through the wall of the duodenum and the tumor is excised, after which the defect in the wall of the duodenum is closed by the usual method.

Malignant Tumors

When there is no evidence of metastasis and no irremovable extension to the surrounding structures, excision of a portion or all of the duodenum is indicated for a primary malignant tumor When the tumor is a carcinoma of the papilla of Vater extension very commonly occurs in the ampulla and the head of the pancreas so that the operation described for resection of the head of the pancreas should be performed (see chapter on The Pancreas) A less radical operation but one that does not offer so good a prospect for cure is local excision of the lesion. The anterior duodenal wall in the descending portion is opened and the lesion with at least .5 cm. of surrounding wall is excised. If the ampulla is removed, the pancreatic duct may have to be ligated and the common bile duct transplanted to a lower portion of the duodenum. An alternative procedure is to ligate the common-bile duct and do a cholecystenterostomy below the point of resection. Carcinoma of the papilla of Vater or of the ampulla is usually associated with extreme dilatation of the common bile duct and enlargement of the gallbladder together of course with jaundice and in the locally inoperable cases a palliative cholecystenterostomy may be done. A malignant tumor of the duodenum below the level of the papilla should be removed by sectioning the duodenum above and below the tumor and anastomosing the upper portion either to the lower portion of duodenum or to the jejunum. If the jejunum is used, the distal duodenal stump is closed. Malignant tumors of the duodenum have the same gross characteristics as those in the stomach and are associated with induration of the duodenal wall and usually ulceration of the mucosa. If the duodenum is obstructed by an inoperable tumor a posterior gastrojejunostomy may be performed.

Duodenal Ulcer

If operation is performed for an unperforated duodenal ulcer one may properly assume that the patient has been subjected to prolonged medical treatment without relief of pain or pyloric obstruction, or that he has had repeated, frequent, severe hemorrhages. If an ulcer is found in the course of an operation for something else unless pyloric obstruction is evidently present or unless the ulcer appears in imminent danger of perforating no surgical treatment should be used for it and it may be dismissed from the present consideration. For the ulcer that demands surgical attention,

a multiplicity of surgical procedures have been devised. Most of these operations, with the possible exception of pyloroplasty are satisfactory enough as far as the cure of the duodenal ulcer is concerned. Unfortunately however the drainage of acid gastric juice into a portion of the intestine not fitted to receive it results in the formation of a high percentage of ulcers in the intestine, and this has immeasurably complicated the problem of duodenal ulcer By experimental investigation it has been found, and this has been confirmed by an abundance of clinical material that the farther one goes down the intestinal tract from the pylorus the less resistant the mucosa of the intestine becomes to hydrochloric acid. This is partly due to the protective effect of the bile and pancreatic juice, which serve to dilute the hydrochloric acid, but in addition the upper part of the small intestine secretes considerably more succus entericus than the lower part. The only strongly alkaline juice found in the intestine is the pancreatic juice, and the reduction in the acidity of the gastric contents when they enter the intestine is largely the result of dilution of the acid by the three secretions the bile, the pancreatic juice and the succus entericus. If one drains the duodenum and its three contents below a loop

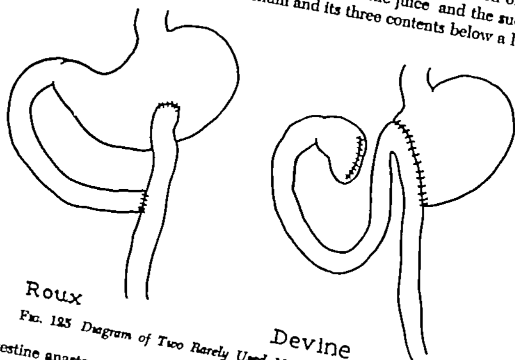


Fig. 125 Diagram of Two Rarely Used Methods of Anastomosis.

of intestine anastomosed to the stomach, ulcer of the anastomosed intestine invariably follows. A loop of jejunum that is connected to the stomach should always receive duodenal contents as a protection to its mucosa, and this is the grave fault of the Roux type of anastomosis a diagram of which is shown (Figure 125) and which should never be used unless absolutely necessary All operations on the stomach designed to heal duodenal ulcer are based on three changes the operation may produce. First,

the stomach may empty faster thus exposing the duodenum to acid for a lesser period of time. Second, the acid may be diluted by duodenal contents regurgitating into the stomach. Third, the acid secretion of the stomach itself may be reduced.

Pyloroplasty which had a much greater vogue some years ago than it has at the present time, but which is still used occasionally produces two of the changes mentioned above. It allows the stomach to empty faster and it permits greater duodenal regurgitation. It may be combined with excision of the ulcer and, particularly when a bleeding ulcer is present this is of undoubted value.

Posterior gastrojejunostomy, particularly if done in unselected cases such as those with high acid and no obstruction, is followed in at least 10 per cent of cases by jejunal ulcer The operation decreases the empty ing time of the stomach to some degree permits the regurgitation of jejunal contents into the stomach, but connects to the stomach a portion of the bowel not always capable of receiving the acid contents without damage In those cases where a more extensive operation cannot safely be done, posterior gastrojejunostomy is the operation of choice.

Anterior gastrojejunostomy requires that the jejunum be connected to the stomach at a lower point in the bowel, with consequently more danger of jejunal ulceration and less protection from the duodenal fluids. When an entero-enterostomy is done, this also decreases the amount of duodenal fluid reaching the stoma. An advantage of the anterior anastomosis is that if a jejunal ulcer should form, it is more easily dealt with.

Gastroduodenostomy which offers the more resistant duodenal mucosa of the duodenum to the gastric juice, provides a wide stoma to decrease the emptying time of the stomach and gives good regurgitation but does not invariably protect against the formation of secondary ulcer When such an ulcer does form it is apt to be located at a point near the bile and pancreatic ducts, and may produce serious complications not easily remedied by surgery

The most satisfactory operation we have at the present time to cure duodenal ulcer and prevent jejunal ulcer is extensive gastrectomy with a wide stoma between the stump of the stomach and the jejunum which means an anastomosis of the Polya or Hofmeister Finsterer type. The acid of the stomach is not secreted in the pyloric portion of the stomach but in the body and fundus although there is some evidence that removal of the pyloric end of the stomach decreases the secretion of acid by the remainder of the stomach. Resection of the stomach for duodenal ulcer should not however be limited to the pyloric portion, but should include a considerable portion of the acid secreting body or a total of about three-fourths of the stomach The Devine exclusion operation a dia gram of which is shown, in which the jejunum is anastomosed to the stump of the stomach and the pylorus is left in almost invariably results

in the formation of a jejunal ulcer within a short period of time This operation may have a place in the surgery of the stomach as the first stage of a resection when the patient cannot stand the entire procedure, but the second part of the operation should be done as soon as the patient s condition permits.

Vagotomy

Vagotomy or what might more properly be termed vagus neurectomy has been performed in recent years either alone or in combination with some other procedure, for the treatment of duodenal ulcer The nerves may be cut above the diaphragm by the transpleural route or an abdominal approach may be employed. If the abdominal route is chosen the esophagus may be cut loose from its diaphragmatic attachments and pulled down slightly so that the nerves can be cut at the lower end of the esophagus, or the nerve trunks may be cut below the diaphragm as they pass onto the stomach. There is considerable difference of opinion about whether all the vagus fibers can be severed in all cases by any other approach than the transpleural, but they apparently can be in most cases. Satisfactory vagotomy is considered to have been accomplished if there is an abolition of acid response to insulin induced hypoglycemia.

Following vagotomy the patients frequently develop abdominal distention during the early postoperative period. Although this subsides in a few days, delayed emptying of the stomach persists for a long time, and in some cases is so pronounced that an operation is necessary for its relief Because of this, some surgeons have combined posterior gastroenterostomy with vagotomy and others do a subtotal gastrectomy thus in the latter case at least reducing vagotomy merely to an accessory procedure in the treatment.

In the patient with a jejunal ulcer following either a gastrojejunostomy or a subtotal resection, if a medical regime is not sufficient to cure the lesion, transthoracic vagotomy may be indicated, or if the surgeon wishes to resect the lesion, a subdiaphragmatic vagotomy may be done at the same time. If the abdomen is to be opened, it seems doubtful if enough more would be accomplished by a supradiaphragmatic vagotomy to subject the patient to another major operation.

Perforated Duodenal Ulcer

A perforated ulcer on the anterior surface of the first part of the duodenum is readily accessible and can be simply and easily closed by the technique described for the closure of perforated gastric ulcer

When the perforation is located on the posterior surface and just below the pylorus, free leakage may occur into the lesser sac, but a little farther down in the duodenum the perforation is commonly closed by the pancreas. By opening through the gastrohepatic omentum the stomach and

duodenum may often be pulled down sufficiently to expose the perfora tion. If this maneuver and mobilization of the duodenum by cutting the peritoneum on its lateral border and rolling the duodenum inward are not sufficient to expose the hole an opening must be made in the anterior wall of the duodenum and the perforation attacked from within. A few inter rupted sutures of silk through the entire thickness of the wall of the bowel are sufficient to close the perforation If an operation is done to cure an ulcer that has perforated in the past or that has bled repeatedly it is wise to include the first part of the duodenum in the resection of the stomach.

Bleeding Ulcer

When the abdomen is opened, the small bowel may be dark in color due to presence of blood. When the stomach is found to be normal and induration or scarring is apparent in the duodenum, an incision parallel to the long axis of the duodenum may be made, the opening pulled apart by means of Allis forceps and the mucosa inspected. Blood can be sucked and sponged away and the base of the ulcer is lightly cauterized and sutured with silk or catgut.

If the patient s condition will permit however partial gastrectomy and removal of the ulcer bearing portion of the duodenum is a more depend able procedure.

TECHNIQUE

Jaboulay s Pyloroplasty

This may be combined with the excision of an ulcer on the anterior duodenal wall. An Allis forceps is placed on the duodenum about 4 cm. below the pylorus, and another forceps is applied on the anterior surface of the stomach a similar distance above the pylorus. After the field is packed off an incision is made between the two forceps, bifurcating and passing around the duodenal ulcer (Figure 126A) Allis forceps are now applied to the incision at each side of the pylorus, and these are pulled apart, thus bringing the stomach and duodenal ends of the incision together (Figure 126B) The first Allis forceps are now removed and the incision is sutured in a transverse direction, beginning at the lesser curvature side and using 00 chromic catgut on a curved needle and a Connell stitch (Figure 126C) This will invert the mucosa and is continued to the greater cur vature side where it is locked and then, as a Lembert stitch, goes back to its starting point, where it is tied to the original end (Figure 126D)

Finney Pyloroplasty

This operation is somewhat similar to the one above, except that the incision is made along the inferior surface of the duodenum and just above the greater curvature of the stomach (Figure 127A) The duo-

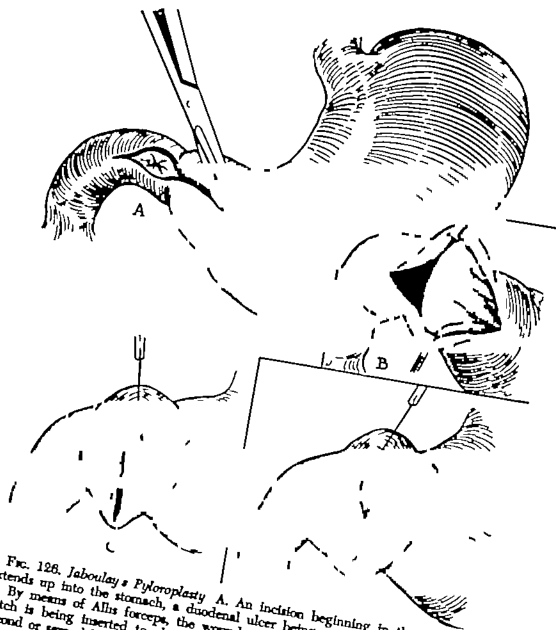


FIG. 128. *Jaboulay's Pyloroplasty* A. An incision beginning in the duodenum extends up into the stomach, a duodenal ulcer being excised at the same time. B By means of Allis forceps, the wound is drawn widely open. C. A Connell stitch is being inserted to close the wound in a transverse direction. D The second or serosal layer of sutures is being put in.

denum is first mobilized by cutting the peritoneum along its lateral surface. An Allis forceps is placed on the stomach almost 4 cm. from the pylorus and as close to the greater curvature as the vessels will permit. Another Allis forceps is placed on the duodenum 4 cm. from the pylorus and stomach and duodenum are approximated. A running serosal stitch is used to unite the stomach to the duodenum. An incision is now made in the duodenum near the suture line and is extended up through the pylorus and down a similar distance on the stomach. This inverted V-shaped incision is now sutured as in a gastrojejunostomy (Figure 127B)

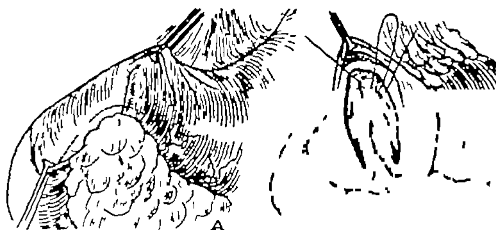


FIG. 127 *Finney Pyloroplasty* A. Allis forceps applied to stomach and duodenum draw them out in a straight line. The dotted line shows the proposed incision. B The duodenum has been mobilized by an incision through the lateral peritoneum. The second posterior layer of sutures is being inserted between stomach and duodenum.

Gastroduodenostomy

In a sense, the two pyloroplasties just described are gastroduodenostomies, but since the attack is primarily on the pylorus they are commonly not thought of as such and the name is reserved for the operation about to be described.

The duodenum is mobilized by cutting the peritoneum on its lateral surface and pulled medially by Allis forceps applied about three finger breadths apart. Similar forceps are applied to the stomach near the pylorus and greater curvature, at points that can be approximated to the clamps on the mobilized duodenum. Rubber-covered clamps may be put on the duodenum and the stomach, or the region may be well packed off and stay sutures of catgut used. A running serosal stitch of 00 chromic catgut is inserted to unite the outer layers of the stomach to the outer layers of the duodenum. Incisions about 4 cm. long are made in the duodenum and the stomach, sponging away the contents as they appear or removing them by suction. All the layers of the duodenum are now approximated to all the layers of the stomach by a continuous running suture, which starts away from the operator When it reaches the angle the suture is locked and continued back to the starting point all the layers of the anterior surface of the stomach being sewed to similar layers of the duodenum with a Connell stitch. This is tied to the original end when the layer is completed. Returning now to the first suture, a serosal stitch of the Lembert type is put in on the anterior surface.

Excision of Diverticulum

Since diverticula are usually located in the second part of the duodenum, the duodenum should be mobilized by incising the peritoneum

along its lateral surface and rolling it inward, or separating the pancreas from it and rolling it outward (Figure 128) The sac should be dissected free and its neck clamped with a small Payr clamp or heavy hemostat. A few sutures are taken through the neck of the sac below the clamp,

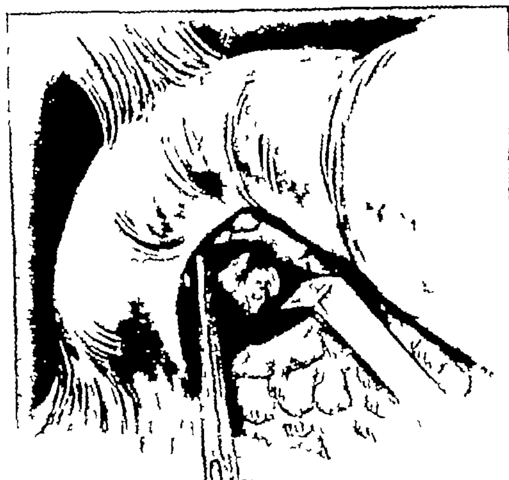


FIG 128 *Removal of Duodenal Diverticulum* The pancreas has been sufficiently separated from the curve of the duodenum to expose the diverticulum, and a clamp has been applied to its neck

after which it is removed and the duodenal wall still further inverted by a serosal stitch of the Lembert type. Care should be taken not to constrict the duodenum. This is best done by putting in the sutures in a direction at right angles to the direction of the bowel If it was necessary to open the duodenum to find the diverticulum, a hemostat may be inserted into it the fundus grasped, and the sac inverted into the duodenum. It can then be excised and the defect in the duodenal wall closed in layers.

Subdiaphragmatic Vagotomy

Through a high paramedian, midline or transverse incision, a hand is inserted above the liver and with scissors the left lateral ligament is cut.

A finger is passed around the upper part of the stomach and, with this as a guide, a catheter is passed around the stomach and clamped, to be used to pull the stomach downward. The left vagus passes downward from the anterior aspect of the esophagus to the anterior and superior surfaces of the stomach, and forms the anterior gastric plexus. The right vagus passes from the posterior surface of the esophagus to the postero-inferior aspect of the stomach, forms the posterior gastric plexus in that region, and then joins the celiac plexus. When the nerves are not visible because of the difficulty of exposure, they must be identified by palpation. This is not difficult since they feel like taut strings when placed under tension Each nerve is grasped with a hemostat, cut, pulled down, and a segment of it is removed. By use of the catheter, the stomach is rotated in each direction until all the filaments have been found and severed.

The technique may be modified by inserting a finger in the esophageal hiatus and separating and cutting the esophageal attachments of the diaphragm, so that the esophagus can be pulled downward a few centimeters. The nerve fibers are then identified and cut as described above.

Vagotomy by the transpleural route is described in the chapter on The Mediastinum and Contents.

(Other operations used in the treatment of duodenal ulcer are described in the chapter on The Stomach.)

POSTOPERATIVE CARE

This is essentially the same as that described in the chapter on The Stomach.

CHAPTER XVIII

The Jejunum and Ileum

PREOPERATIVE TREATMENT
INCISION
EXPLORATION
LESIONS OF THE JEJUNUM AND ILEUM
- Intestinal Obstruction
- Volvulus
- Intussusception
- Adhesions and Bands
- Hernias
- Tumors of the Small Intestine
- Foreign Bodies in the Small Intestine
- Regional Enteritis
- Tuberculosis
- Actinomycosis
- Mesenteric Lymphadenitis
- Mesenteric Thrombosis and Embolism
- Diverticula
- Congenital Anomalies
- Wounds and Perforations
- Fecal Fistula
- Paralytic Ileus

TREATMENT
- Volvulus
- Intussusception
- Adhesions and Bands
- Hernia
- Tumors of the Small Intestine
- Foreign Bodies
- Regional Enteritis

Tuberculosis
Abdominal Actinomycosis
Mesenteric Lymphadenitis
Mesenteric Thrombosis and Embolism
Diverticula
Anomalies of the Bowel
Wounds and Perforations
Fecal Fistula
Paralytic Ileus

TECHNIQUE
Enterostomy
Resection and End to-End Anastomosis
Lateral Anastomosis or Entero-Enterostomy
Exteriorization of Bowel
Removal of Diverticulum

POSTOPERATIVE CARE

The Jejunum and Ileum

Surgery of the small intestine, with the exception of the duodenum, is largely the surgery of intestinal obstruction. Regardless of the nature of the lesion, it is usually interference with the passage of intestinal contents through the lumen of the bowel that causes the serious train of symptoms demanding surgical relief.

PREOPERATIVE TREATMENT

Chemical and fluid balance is restored by the administration of saline solution intravenously If a strangulation obstruction has been present for any length of time transfusions are given. In the mechanical type of obstruction, the Miller Abbott tube is introduced and suction maintained. When operation is to be performed immediately a Levine tube is introduced into the stomach and is kept in place and suction continued during the operation. In the mechanical obstruction, if the Miller Abbott tube cannot be passed or does not relieve the distention after a period of five or six hours, operation must be performed.

INCISION

If a mass is palpable in any part of the abdomen, if distention is more evident in one place than another if pain is localized in one particular quadrant, or if X ray examination reveals the location of the obstruction, a rectus or paramedian incision should be made over that area. If there is no clue to the site of the lesion, a right paramedian incision, long enough to admit the surgeon s hand and centered at the level of the umbilicus may be extended upward or downward as the findings indicate and gives adequate exposure of most of the abdomen. When it is suspected that the lesion may be on the left but there is not enough evidence to warrant making the incision on that side a midline incision above or below the umbilicus may be preferable Because of the stronger abdominal wall it leaves, a muscle-splitting incision of the McBurney type is desirable if one expects to deal with infected bowel, but exploration of the abdomen

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through such an incision must necessarily be limited, and any surgery done on the bowel will have to be more or less confined to intestine located on the side of the abdomen in which the incision is made. In incising the peritoneum in the presence of abdominal distention, extreme care must be used to avoid cutting the bowel which will be pressed tightly against the peritoneal wall, the intestine itself may be so thinned out that it resembles peritoneum. If the bowel should be accidentally cut, the opening should be quickly closed with a hemostat before the intestinal contents, which are under pressure, have a chance to escape in quantity The opening in the intestine is closed by sutures taken under the clamp. After the clamp is removed, the intestinal wall should be turned in by a continuous Lembert suture of 00 chromic catgut.

EXPLORATION

As soon as the peritoneal cavity is opened, it may be evident that there is an increased amount of fluid present. This is indicative of inflammatory disease in the abdominal cavity peritoneal irritation, or interference with the circulation of some intra abdominal organ. If the fluid is serofibrinous or purulent in character one can conclude that the peritoneal irritation has changed to actual inflammation, and a source for the infection must be found. When purulent exudate has been present in the abdominal cavity for several hours the infection may extend to the peritoneal covering of the intestine, and the bowel, instead of appearing smooth and shiny takes on the dull and roughened appearance of generalized peritonitis. In addition to this flecks of fibrin and, in the later stages, adhesions between the coils of bowel will be seen. If the peritoneal fluid is pinkish in color due to the presence of red blood cells, the usual origin of the blood is strangulated bowel. When the number of red blood cells in the peritoneal fluid is so great that it is indistinguishable from blood, one may be dealing with strangulated bowel in an advanced stage but other causes of blood in the peritoneal cavity, such as ruptured ectopic pregnancy or a lacerated viscus, must be kept in mind. Other causes of pink or bloody peritoneal fluid are strangulated ovarian cyst, pedunculated fibroid with a twisted pedicle and strangulated omentum.

When an incision is made in or near the midline in a patient with intestinal obstruction, the first loop of bowel that presents itself into the incision is usually a distended loop a portion of bowel located above the point of obstruction. Such a distended loop should be drawn out of the incision and inspected in an attempt to determine what part of the small intestine it is, since the operative procedure used may depend somewhat on the location of the lesion. There are certain definite differences between jejunum and ileum, which are quite evident in the normal intestine but when distention has occurred may no longer be apparent. Normally for instance, the jejunum is larger in caliber and its walls are thicker and

darker in color than those of the ileum. When the jejunum is grasped between the thumb and finger the circular folds may be palpable. These folds are present but small in the upper part of the ileum, and disappear entirely lower down The jejunum normally occupies the umbilical and left iliac regions, and the ileum is found in the hypogastric, umbilical right iliac, and pelvic regions. The terminal ileum normally lies in the pelvis and ascends over the right psoas muscle to enter the medial side of the cecum. With the development of distention however these normal positions of the bowel may be lost. The intestine becomes so distended that the presence or absence of mucosal folds cannot be determined, and of course the size of the intestine will be no indication of the part one is dealing with. The only difference between jejunum and ileum that will be present in spite of distention is to be seen in the character of the mesentery In the jejunum nearest the duodenum, the loops of the mesenteric vessels are primary the vasa recta are long and regularly distributed, and the lunettes or transparent spaces between the vessels are conspicuous. As one passes down the bowel, the mesenteric loops begin to show secondary loops and farther down tertiary loops, and increased amounts of fat are seen in the mesentery so that in the lower ileum the vessels are almost entirely obscured by fat tabs.

The surgeon now inserts his hand into the abdominal cavity and feels about for abnormal masses or bands. If any such are felt, the bowel in that region is drawn into the wound. If no abnormalities can be discovered, it will be necessary to follow the intestine upward from a collapsed loop until the point of obstruction is located. In order to determine which is the distal end of a loop of bowel the loop should be drawn out of the abdomen and arranged so that its mesentery is not twisted. By passing the hand inward, the mesentery can be felt from its origin on the posterior abdominal wall outward to the bowel. The root of the mesentery is 15 cm. long and extends from the duodenojejunal flexure on the left side of the body of the second lumbar vertebra downward and to the right, to the region of the right sacroiliac articulation or the point of attachment of the cecum. From its root, the mesentery rapidly spreads out to be attached to the entire length of jejunum and ileum. From this anatomical fact it will be evident that when a loop of bowel is held in the long axis of the body with its mesentery untwisted, the distal end of the loop will be that toward the patient's feet and the proximal end that toward his head. The collapsed bowel is now followed proximally to the point of obstruction, a few inches of intestine being pulled out and the distal intestine put back as one proceeds The absence of gas and fluid in the intestine below an obstruction makes the bowel appear much smaller than normal, so that the ileum, for instance, may be only 1.5 to 2 cm. in diameter

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struction must be looked for in the colon, if the entire colon is also ballooned up one may be dealing with an obstruction of the paralytic type. If on the other hand, there is no distention of the small or large intestine as far up as the duodenojejunal flexure the duodenum must be carefully investigated because, as mentioned in the chapter on The Duodenum, small bowel obstruction may occur here with rapid prostration and early collapse of the patient.

If the symptoms for which the operation is being performed are those of intestinal obstruction, but if examination of the bowel does not suggest that an obstruction is present, a systematic examination of the abdominal cavity should be undertaken. The cecum should be pulled up and the condition of the appendix determined. A hand should be inserted into the pelvis, and the tubes, ovaries, and uterus palpated. Tumors or abscesses developing from the pelvic organs may, by pressure on the bowel and by extension of the inflammatory process to the neighboring coils of intestine, produce symptoms of intestinal obstruction. An appendiceal abscess walled in, as it is, by coils of ileum, may also initiate small bowel obstruction. If an appendiceal abscess is encountered it should be drained, and the appendix removed if this can be done without undue soiling of the general peritoneal cavity or too prolonged an operation. A pelvic abscess originating from the tubes should be opened and aspirated after packing off the neighboring bowel with moist gauze. Then if the tubes and ovaries are not too firmly bound down by the inflammatory process, they should be removed. An exception to this may be made in the case of a young woman leaving the organs in and depending on penicillin or sulfonamide therapy Tumors of the uterus and ovaries, which likewise may cause intestinal obstruction should be removed. The pelvic colon should be palpated to rule out the presence of carcinoma, paying particular attention to the rectosigmoid junction. General exploration of the coils of small bowel in the lower and upper abdomen should be done by palpation, and any abnormal mass brought into the wound for examination. The size of the kidneys should be noted. The gallbladder and liver should be examined and evidence of induration of the wall of the stomach, duodenum or head of the pancreas sought for If the cause of the patient's symptoms is evidently in the upper abdomen as determined by this examination, the incision should be enlarged upward and the appropriate procedure performed. If from the character and amount of peritoneal fluid, it is evident that some inflammatory process is present in the abdominal cavity and the examination conducted as has been described does not reveal the cause of it, search should be made for Meckel's diverticulum. Starting at the cecum, the ileum is drawn into the wound a few inches at a time and, after it has been inspected, replaced into the abdomen This is continued until the bowel has been examined for a distance of at least 1 m. from the ileocecal junction.

LESIONS OF THE JEJUNUM AND ILEUM

Intestinal Obstruction

General Considerations Obstruction of the bowel may be acute or chronic depending on a number of factors. Any complete obstruction of the lumen of the small or large bowel produces rapid abdominal distention, but partial obstruction of the colon may be tolerated for long periods with little systemic reaction. Although this is true in some degree for the small intestine also, any narrowing of the lumen of the duodenum jejunum, or ileum is much more apt to give rise to pain and vomiting When the obstruction is gradual in onset, the bowel has a chance to compensate by hypertrophy of the muscular wall and thus provides the more vigorous peristalsis necessary to push the contents through the narrowed lumen. Associated with a gradually developing partial obstruction there may also be dilatation of the bowel, which may be present for a long period with few or no symptoms. An equal degree of obstruction produced suddenly may cause immediate and severe symptoms and the higher in the intestine the obstruction is located the more acute and fulminating these symptoms will be. When, instead of or associated with mechanical obstruction of the lumen, there is interference with the blood supply of the bowel the systemic and peritoneal reaction is relatively early in onset, regardless of the location of the lesion, although gangrene of a large section of small bowel may be present for several hours without producing any striking abdominal signs Paralysis of the bowel musculature such as occurs in generalized peritonitis, is gradual in onset and the symptoms due to vomiting and distention are added onto the symptoms of a severe septic process.

The Miller Abbott tube has revolutionized the treatment of acute intestinal obstruction of the mechanical type since it is now seldom necessary to operate immediately for this condition. The bowel can be emptied by suction while measures are taken to improve the general condition of the patient. In many cases decompression permanently relieves the obstruction, but in any case operation can be done at the most opportune time In the past in dealing with an extremely sick patient, it was necessary to make a small incision, grasp the first distended loop of bowel that presented itself in the wound, and perform an enterostomy without exploring the abdominal cavity to determine the cause of the obstruction. At present this emergency procedure is necessary only when the bowel must be drained at once or when the tube cannot be passed or does not function. The purely mechanical obstruction can be relieved at least temporarily without operation, and the obstruction produced in association with strangulation of the bowel demands more than an enterostomy If when the abdomen is opened, even in the most acutely ill patient, there

is seen to be a great excess of peritoneal fluid, and particularly if this fluid is pink or bloody, a strangulation of the bowel is present and must be relieved. Anything less than this is futile. One should keep in mind that it is possible for a segment of strangulated bowel to be so walled off by neighboring coils of intestine that when the peritoneal cavity is opened there will be no evidence of its presence except an increase in the amount of peritoneal fluid.

Volvulus

Twisting of the bowel, or volvulus, although usually seen in the sigmoid colon, occurs occasionally in the small intestine. Frequently associated with volvulus, and instrumental in causing it, are peritoneal adhesions or fibrous bands. It is also probable that some defect in the mesenteric attachment is present in some cases Abnormally vigorous peristalsis is thought to be an important factor in causing the bowel to twist on its mesentery In occasional cases, particularly where peritoneal bands are present, there may be a mechanical obstruction of the bowel but more commonly the obstruction is of the paralytic type and is due to interruption of the blood supply to the loop of bowel by the twist in its mesentery Circulation through the veins is first interrupted, and later the arterial supply is cut off, the wall of the intestine becomes engorged with blood, and gangrene of the loop soon follows. In the stage of engorgement, there is a transudation of clear fluid from the involved loop but within two or three hours red blood cells appear and the fluid takes on a pinkish color Later as the process continues, the peritoneal fluid is actually bloody in appearance, and, along with the passage of this gross blood, bacteria enter the peritoneal cavity and the fluid lost from a gangrenous loop becomes definitely toxic in character When the incision is made, a distended loop of bowel located above the point of obstruction commonly presents itself into the incision. If this is pushed back and the hand is inserted into the abdominal cavity it is usually a simple matter to locate the indurated loop of intestine and bring it into the incision, but one must remember that gangrenous bowel is extremely friable and if tugged on too roughly it may rupture. Fortunately adhesions between such a loop of bowel and the surrounding intestine or omentum if present at all, are usually easily separated. The strangulated intestine when delivered into the wound, will be seen to be in any stage of engorgement, from deep red to brownish black. The peritoneal covering may no longer be smooth and shiny and, in late stages, may be covered with deposits of fibrin or fibrinopurulent exudate, the latter evidence of the infection which would soon have led to generalized peritonitis. As the loop becomes distended its walls are thinned out and perforation occurs easily The mesentery also will show the same degree of engorgement and will be twisted on its axis, usually from 180 to 360 Volvulus of the terminal ileum is occasionally

associated with a volvulus of the cecum. In these cases, the cecum will be seen to have a mesentery that is a continuation of that of the ileum.

Intussusception

Inversion of one portion of the intestine into another usually occurs in babies during the first year of life, but occasional cases are seen in children and adults. The most common site of the beginning of the telescoping process is the ileocecal junction, and from here the ileum may pass through the entire colon and appear at the anus. In the small bowel the production of intussusception is favored by the presence of a tumor or diverticulum, which serves as a starting point for the invagination. It is probable also that hyperactive peristalsis may be a factor in initiating the process. Intussusception may occur in any part of the small or large intestine which is not fixed, and regardless of the location the operative findings are the same. The portion of the intestine that has been invaded is intensely enlarged, and in it a firm mass, the telescoped intestine, can easily be felt. Once the invagination of bowel has begun, the contraction of the surrounding intestine or intussuscipiens begins gradually to cut off the blood supply of the contained portion or intussusceptum, so that the latter becomes full and dark in color and eventually gangrenous. The swelling of the intussusceptum obstructs the lumen of the bowel and produces the usual dilatation seen in the intestine above an obstruction. Below the intussusception the bowel is usually empty. In the small intestine, the usual invagination extends only a very short distance and produces a firm tumor which can easily be identified by the exploring hand and brought into the incision. If necessary one can start with a length of collapsed bowel and follow it upward to the point of obstruction.

Adhesions and Bands

Peritoneal adhesions are usually the result of a previous operation, and may extend between adjoining loops of bowel, between bowel and peritoneal wall, or between bowel or mesentery and some other abdominal viscus. It is usually good judgment in operating for intestinal obstruction due to adhesions to enter the abdomen through the site of the previous operative incision, excising the scar in the skin *en route* but because of the possibility that the intestinal wall may be adherent to the peritoneum at that point, one must use extreme care in incising the peritoneum and entering the peritoneal cavity. By far the greatest majority of peritoneal adhesions cause no symptoms whatsoever and it is only in occasional cases that constriction or kinking of the bowel occurs. If the operation that caused adhesions was a recent one, the adhesions will probably be fibrinous in character and easily separated. After a longer time dense fibrous tissue appears and the adhesions can no longer be peeled off the intestine but must be carefully cut. Although adhesions may be present throughout the en-

tire abdomen, investigation will usually reveal that one particular band or cord has caused the symptoms. If necessary this point may be located by searching for the junction between distended and collapsed bowel. An adhesion between two adjoining loops of bowel may in the course of time become stretched out so as to form a fibrous cord, and similar bands may be produced by omentum, Meckel's diverticulum, a Fallopian tube, or an appendix. Aside from the adhesions that result from simple inflammatory disease or the trauma of an operation, adhesions may also be produced by carcinomatous implants on the peritoneal surface of the bowel, tuberculous peritonitis, and actinomycosis The latter disease is particularly characterized by the formation of extensive abdominal adhesions, although intestinal obstruction does not commonly result from them.

Hernias

A portion of the bowel may easily be obstructed in a hernial ring and, with swelling of the bowel interference with its blood supply results, and ultimately gangrene may occur The most common locations for hernias are the inguinal femoral, and umbilical regions but incisional and ventral hernias are also common. In these cases the approach to the incarcerated bowel is through an incision over the hernia, this subject is discussed under diseases of the abdominal wall. There remain certain intra abdominal hernias commonly not diagnosed before operation the treatment of which must be through an abdominal approach. The foramen of Winslow is a natural opening in the abdominal cavity and occasionally the small bowel may pass through this and enter the lesser sac. Sometimes this passage of bowel out of the main peritoneal cavity is so extensive that as soon as the abdomen is opened it is obvious that small intestine is missing from its normal habitat. In other cases, pain in the upper abdomen will have directed the surgeon s attention to this region and a mass will be palpated above, behind, or below the stomach. Similarly the jejunum may prolapse extensively behind the ligament of Treitz into the omental bursa. Hernia may also take place through one of the normal potential openings in the diaphragm or through a tear in this structure· the treatment of this condition is considered under the diaphragm. Other less frequent locations of hernia are the potential openings in the region of the cecal fossae, the intersigmoid fossa, and the obturator canal. The exploring hand will feel fixation of the small bowel at one of these points, and, if the obstruction has lasted for any length of time, there will be distended bowel above and collapsed bowel below

Tumors of the Small Intestine

Malignant tumors occur in the small intestine in the form of adenocarcinoma or sarcoma. The benign tumors fibromata adenomata, lipo-

mata, and myomata, are occasionally seen. They are usually pedunculated and form a rather firm mass, which can be felt in the lumen of the intestine. Carcinoid tumors of the small intestine, similar in nature to those described in the appendix may occur singly or several of them may be present. They are usually benign, although metastasis has been known to occur from them. Typically the tumor is in the form of a nodule in the submucosa of the bowel which projects into the lumen and can be felt in the intestinal wall Lymphosarcoma may begin in the small intestine or may be part of a more generalized process. In this condition the wall of the bowel becomes greatly thickened throughout most of its length, and associated with it there is enlargement of the mesenteric glands. Perhaps the most common symptom of a benign tumor of the small intestine is hemorrhage, either occult or gross. It does not commonly cause intestinal obstruction but may originate intussusception or volvulus.

Foreign Bodies in the Small Intestine

Most of the objects so commonly swallowed by children or mentally irresponsible persons pass through the intestine without incident but occasionally obstruction may be produced by them. If the object has a sharp edge there is some tendency also for it to perforate the intestinal wall, with resulting peritonitis Endogenous bodies such as gallstones, fecoliths, or bezoars, may occasionally cause intestinal obstruction, more rarely masses of worms, the Ascaris Lumbricoides, may cause intestinal obstruction, particularly in children. There is usually no difficulty in locating the foreign body by palpation of the bowel or in determining the point of obstruction.

Regional Enteritis

This is a disease of unknown etiology in which the intestinal wall becomes thickened and the mucosa ulcerated, and in which there is a strong tendency toward perforation of the intestinal wall and fistula formation. The commonest site of the disease is the terminal ileum but it may be found in the colon or any part of the small intestine. The segment of intestine involved may be only a few inches or several feet long, and there is a tendency for the lesions to be patchy in distribution — for instance, a portion of the jejunum may be affected and then, several feet farther down, another area may be seen. The intestinal lumen is rarely completely obstructed but it is always narrowed, and symptoms of chronic ileus are commonly present. The thickening of the intestine that the disease produces makes the involved areas easily located by the examining hand. As the bowel is drawn up into the wound, it must be remembered that perforation may have occurred into a neighboring loop of bowel, and any adhesions found should be separated most carefully

Tuberculosis

In the presence of pulmonary tuberculosis tuberculous involvement of the mucosa of the small intestine is extremely common. It has a tendency to locate in the lymph follicles, and in some cases only a slight thickening of the intestinal wall in these areas can be noticed. In time, however there is a tendency to scar formation, as a result of this, multiple constrictions of the intestinal wall with partial obstruction may be seen. In tuberculous peritonitis the disease is usually confined to the serous covering of the intestine where multiple tubercles will be evident and the intestine may appear to be covered with a mass of small nodules. The parietal peritoneum is similarly involved, and there is a great excess of clear peritoneal fluid present. Rarely the involvement of the intestinal wall may be deep enough to weaken it and cause perforation.

Actinomycosis

In this disease, besides the typical appearance of an infective granuloma, thickening of the bowel, and ulceration of the mucosa, there are multiple dense adhesions and usually many pockets of pus in the abdominal cavity The adhesions are so dense that to separate them is a *time-consuming and useless procedure unless bowel obstruction is present* and must be relieved.

Mesenteric Lymphadenitis

This disease is occasionally seen in children and causes symptoms that may closely resemble those of acute appendicitis It is characterized by enlargement of the mesenteric and retroperitoneal glands, without change in the appearance of the intestine. The maximum size of the glands is usually about that of a lima bean. The enlargement is due to simple hyperplasia but occasionally suppuration takes place.

Mesenteric Thrombosis and Embolism

Embolism of a mesenteric artery is usually the result of a small thrombus that has broken off a vegetation on the mitral valve. Thrombosis of a mesenteric vein may occur spontaneously or as a result of abdominal inflammation, which usually originates in the pelvis or appendix. The superior mesenteric artery is more commonly the site of embolism than the inferior and infarction of the involved segment with sharp demarcation from the normal bowel is seen. The intestine takes on a deep-purple color and blood exudes through its walls into the peritoneal cavity Obstructive symptoms are usually not prominent until late in the course of the disease When the peritoneal cavity is opened, bloody fluid pours out and the great length of gangrenous intestine testifies to the highly fatal nature of the disease

Diverticula

Meckel's diverticulum represents the remains of the vitelline duct the connection between the yolk sac and the primitive digestive tube, and is said to be present in about 2 per cent of bodies. It is represented as an out pouching of the ileum somewhat smaller in caliber than the rest of the intestine and located about 60 cm. above the ileocecal valve. The tip of the diverticulum usually lies free, but it may be adherent to an adjoin ing coil of bowel or to the anterior abdominal wall in the region of the umbilicus. Inflammatory changes may take place in it similar to those of appendicitis. Occasionally rests of gastric mucosa which secrete acid may be present and peptic ulcer with hemorrhage or perforation occa sionally occurs. The diverticulum may sometimes become inverted into the intestinal lumen and serve to initiate intussusception. Coils of bowel, on the other hand, may twist around a fixed diverticulum and cause obstruction by a volvulus. Sometimes the vitelline duct may remain patent from the ileum to the umbilicus, and a fecal fistula will be present. In less severe cases, there is a mucosa lined tube, which does not connect with the intestine but which discharges mucus into the umbilicus, and in which acute inflammatory changes and even abscess formation may take place. Whenever a patient is operated on for acute appendicitis and the appendix does not show the appropriate inflammatory changes, the ileum should be examined for a distance of at least 1 m. from the ileocecal junc tion, to be sure that no inflammation of Meckel's diverticulum is present.

Other diverticula, similar in nature to those that so often occur in the colon, are occasionally seen in the small intestine. These may be true diverticula, consisting of an out pouching of the entire wall of the intestine, or they may be false diverticula, in which the muscular coat is absent. They are frequently multiple, and inflammation of the sac, diverticu litis, occasionally takes place.

Congenital Anomalies

Strictures of the small intestine are seen as a result of inflammatory disease, such as tuberculosis and syphilis, but they may also be congenital in origin. There may be a mere narrowing of the intestine, or the intestine may be represented by a fibrous cord over a considerable distance. In other cases, the intestine abruptly terminates in a blind end, with a lower segment present but entirely unconnected to the upper one. The nature of the condition present cannot be diagnosed in most cases until the baby is operated on.

Abnormalities in the developmental rotation of the bowel may occur and many of these are probably present without causing symptoms. There may be a persistent mesentery for the duodenum, the cecum may remain on the left side or be arrested in the region of the liver There may be

hyperfixation at the duodenojejunal angle, which causes kinking of the duodenum, and the same situation may be present in the terminal ileum, resulting in partial intestinal obstruction.

Wounds and Perforations

The presence of blood or fecal contents in the abdominal cavity points to the presence of a perforation of the lumen. If the hand introduced into the abdominal cavity finds no mass representing the adhesion of adjacent coils of bowel or omentum to the perforated area, the intestine must be inspected over its whole length until the hole or holes are found. Perforation of a typhoid ulcer is most commonly seen in the lower ileum, but a perforation made by a foreign body or by a bullet may be present in any part of the small bowel. Bullet wounds of the small intestine are usually multiple and associated with wounding of the mesentery I have seen the passage of one .22 caliber bullet through the abdomen make eighteen holes in the small intestine. All of these must be carefully sought for and closed. A perforation that has been present only a short time causes peritoneal irritation and effusion, and this soon changes to generalized peritonitis unless the omentum is able to wall off the opening

Fecal Fistula

This is a communication between the lumen of the bowel and the surface of the skin, and may be due to the rupture of an abscess that has an intestinal origin or to a perforating wound of the abdomen. The presence of a foreign body or a granulomatous type of inflammation, such as tuberculosis or actinomycosis predisposes to the development of a fistula.

Paralytic Ileus

Trauma to the bowel, whether as a result of a blow on the abdomen or of prolonged handling of the intestine during the course of an operation, results in some degree of paralysis of the musculature of the intestine. Generalized peritonitis, probably by the paralyzing action of toxin on the bowel musculature, produces the same condition. The entire bowel is diffusely distended with gas and fluid, the colon being involved as well as the small intestine If the condition persists for some time, gangrene and perforation of the bowel may take place, but these complications are not seen as often in this as in the mechanical type of obstruction.

TREATMENT

Volvulus

The distended and dark-colored segment of the bowel is delivered into the incision, and the hand is passed down along its mesentery to the root in a search for fibrous bands, cords, or adhesions that may be cutting

off the blood supply to the loop. If any of these are found, they are cut off with scissors under direct vision if possible If not, by passing a finger on each side of the band and cutting with scissors between the fingers. In simple volvulus, the mere untwisting of the mesentery is sufficient to relieve the strangulation. The loop of bowel is now surrounded by hot moist packs and studied to determine if it is viable. If the peritoneal covering of the bowel has lost its shiny appearance and the wall of the intestine is definitely black and necrotic, or if the peritoneal cavity contains gross blood, one may conclude at once that the portion of intestine involved will not return to normal. When the condition of the bowel is not so obviously hopeless it requires sound surgical judgment to decide what to do. After the strangulation has been relieved and the intestine surrounded by hot packs, the color of the intestine should return to normal within five minutes a slight lessening of the dark color which may result from the escape of the dammed-up venous blood, is not sufficient. Pulsation of the mesenteric vessels should be evident distal to the point where the mesentery was twisted, and the musculature of the intestinal wall should contract when stimulated by pinching. If, after observation, the intestine under suspicion resumes its normal appearance it is put back into the abdomen and no further surgery is necessary If the bowel is not considered to be viable, it must be either resected or exteriorized. Primary resection and anastomosis is the operation of choice, but one must be sure to resect the bowel far enough above and below the obstructed segment to be sure that healthy intestine will be sutured together The anastomosis most simply done is of the end to-end type, but it may be a little safer to close the ends of the bowel and perform a lateral anastomosis near the stumps. If the bowel is very much distended, an enterostomy should be made one or two feet above the anastomosis, and the catheter is brought out through a stab wound to one side of the incision. If the non viable segment of bowel is not over a foot long and if it is not located so high in the jejunum that the loss of intestinal fluids would be of serious consequence it may be exteriorized and a secondary operation performed to unite the two open limbs of intestine left by the sloughing of the gangrenous loop. This method is seldom used, but may be of value when the viability of the bowel is in doubt. The loop is drawn out through the wound, which is closed around it. When the patient is out of danger if the intestine appears to be normal, the wound is reopened and the loop is returned to the abdominal cavity In general, if there is any doubt about the viability of a loop of intestine, it is better not to take a chance on leaving it in the abdominal cavity

Intussusception

The involved segment of bowel is delivered as much as possible into the wound and then, starting at the distal end of the invaginated bowel, it is

hyperfixation at the duodenojejunal angle, which causes kinking of the duodenum, and the same situation may be present in the terminal ileum, resulting in partial intestinal obstruction.

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Tumors of the Small Intestine

In most cases, these should be removed by resecting the segment of bowel in which they are located, and performing an end to-end anastomosis. In occasional cases where the tumor is quite definitely pedunculated, it may be simpler to open the bowel on the anti mesenteric border and cut off the tumor at its base. The incision should be made lengthwise to the bowel and closed in a transverse direction, so as not to narrow the lumen. If the tumor is malignant, the resection of the bowel should be fairly wide and should include enough of the mesentery to catch the lymph glands that drain the region.

Foreign Bodies

The loop of bowel in which the object is located is delivered into the wound and an incision is made in the intestine of sufficient length to permit its removal. If a sharp object is present that has already perforated the lumen of the intestine, the opening may be enlarged sufficiently to allow it to be taken out. The opening is then closed by at least two layers of sutures. After the bowel is returned to the abdomen, a soft rubber drain may be placed near the infected area. When the bowel is obstructed by a mass of worms, the bowel should not be opened unless absolutely necessary since Ascaris Lumbricoides is said to make its way through a suture line into the abdominal cavity The mass can usually be broken up by manipulation through the bowel wall.

Regional Enteritis

If the condition appears to be acute and no obstruction is present, no operation should be done. If the portion of the intestine involved is relatively short, the bowel thickened and partially obstructed, and the rest of the intestine is normal, wide resection with removal of the regional mesenteric nodes and end to-end anastomosis should be performed. This seems to offer the best prospect of cure for the disease but unfortunately recurrences are common. If the intestine is extensively involved or if there are several skip areas, the bowel may be short-circuited around the lesion by making a lateral anastomosis between the intestine above and that below the lesion. If there is an area of the disease high in the jejunum and another low in the ileum, it is better to resect the upper lesion, and either short-circuit the lower lesion or resect it also. If a lateral anastomosis is made above and below an area of ileitis, the amount of intestinal content that passes through the anastomosis will depend upon the amount of obstruction produced by the ileitis. If there is little obstruction, the anastomosis will accomplish very little and the intestine must be cut off and closed above the lesion if the operation is to be of any value. Since a common location of the disease is in the terminal ileum and ascending

pushed and milked upward, making only the gentlest possible traction on the upper segment. If the intussusception has occurred recently it can be reduced with little difficulty In cases of longer duration, however the intussusception may become excessively swollen because of strangulation of the blood supply and fibrinous adhesions may have occurred between the invaginated layers so that reduction is impossible. If this is found to be the case, a lateral anastomosis should be made between the normal bowel above and below the intussusception, short-circuiting the obstructed region. If the intussusception is reducible but it is found after the bowel has been delivered that it is non-viable, it must be resected.

Adhesions and Bands

When one fibrous band is responsible for the bowel obstruction, it is usually a simple matter to locate and cut it, but when the bowel is obstructed in a mass of adhesions one is confronted with a condition that demands the utmost in gentleness and patience. Starting with a segment of collapsed bowel which of course will be below the point of obstruction, the surgeon proceeds to free it proximally by the most judicious use of the knife and scissors. This process is continued until the point of obstruction is reached. When the adhesions at this point are released, no prolonged attention should be paid to the adhesions that remain, since the raw surface left by cutting them tends to promote their recurrence. If the intestine should be inadvertently cut during the process of separating the adhesions, the opening should be quickly grasped with a hemostat or rubber-covered clamp and the bowel closed by two layers of sutures. If any non viable intestine is found it should be resected.

Hernia

The treatment of the bowel incarcerated in a hernia of the abdominal wall is discussed under that subject (page 205) If an internal hernia is found, the bowel should be pulled out of the opening and the opening closed, to prevent recurrence of the accident. If the intestine has entered the lesser sac through the foramen of Winslow or has passed up one of the duodenal fossae and cannot be pulled out, the peritoneal ring may be incised enough to permit passage of the bowel. In rare instances it may be necessary to enter the lesser sac through the gastrocolic omentum and decompress the intestine by puncture with a needle. The opening thus made in the bowel is closed by one or two sutures if necessary One must use considerable care in not pulling too hard on the loop of bowel in a hernia, since the incarcerated intestine may be so weakened by its loss of blood supply that it is easily torn. The herniated loop having been returned to the abdominal cavity it is inspected and any non-viable length of bowel is removed.

should be drained, but little attempt should be made to locate other small areas of suppuration between the coils of bowel. Penicillin therapy is helpful in most cases.

Mesenteric Lymphadenitis

This condition is usually discovered at the time of an operation for what is presumed to be appendicitis. It is doubtful if there is any connection between it and disease of the appendix but the appendix should be removed since the abdomen has been opened. There is no surgical treatment for mesenteric lymphadenitis unless a gland has suppurated and formed an abscess, in which case the abscess should be drained.

Mesenteric Thrombosis and Embolism

The only possible treatment for this disease is resection of the involved segment of bowel and anastomosis between the normal bowel above and below and the safest procedure is to close the ends and make an anastomosis of the lateral type. It should be remembered that the bloody fluid present in the abdominal cavity is toxic in character and it should be removed as thoroughly as possible by suction before the abdomen is closed. The loss of one-third of the small intestine is compatible with normal digestion, but the removal of larger segments may cause inanition. The mortality from this disease after gangrene of the bowel has set in is extremely high, but if the vascular obstruction has not been present very long and the peritoneal fluid is clear resection can be done with more assurance. There have been several instances reported in which at operation the entire small bowel was dark in color and, because of the hopelessness of the condition, the abdomen was closed without doing anything Strangely enough in these few cases recovery occurred spontaneously I have seen this happen once in an operation on a dog, and it may be borne in mind when estimating the prognosis.

Diverticula

Any single diverticulum of the small bowel, and this includes Meckel's, should be removed unless the diverticulum is short and has a wide mouth and is not inflamed. Multiple diverticula, unless confined to a short segment of the intestine that can be resected, should probably not be disturbed. If diverticulitis is present, the diverticulum should be removed, if it has ruptured, the peritoneal cavity in that region should be drained. Any other remnant of the vitelline duct that is accidentally encountered may be removed if it seems to offer a potential danger of producing intestinal obstruction. An abscess of the same structure should be drained and as much as possible of the remnants of the duct excised.

colon the usual procedure is to cut off the ileum above the lesion and perform an ileocolostomy in the middle of the transverse colon, closing the stump of the ileum and leaving it as a blind loop attached to the cecum. When the disease has progressed so far as to cause fistula formation, either between adjacent loops of bowel or to the external abdominal wall, isolation of the involved loop must be very carefully done, and the surrounding normal intestine must be protected by moist packs during the course of the operation. No attention need be paid to the tract between the peritoneum and the skin, but the opening in the intestine should be identified and closed with a clamp until the loop of bowel is dealt with. When a fistula communicates with an apparently normal loop of bowel, this opening should be closed with a double layer of sutures, but it is better not to attempt to suture a hole in a segment of bowel involved by the disease, because of the danger of leakage. In such a case the diseased segment should be removed and an end to-end anastomosis performed between the normal bowel above and below the lesion. Unless some portion of the peritoneal cavity is grossly infected it is better not to use drainage in these cases.

Tuberculosis

Tuberculosis of the small intestine, whether it is tuberculous peritonitis or multiple ulcers of the ileum, is not amenable to direct surgical attack unless one of the ulcers of the bowel has perforated. If such an accident has occurred the lesion should be closed by two layers of sutures and the opening covered by omentum. The opening of the abdominal cavity in tuberculous peritonitis and the removal of the fluid are believed to have some curative value, but probably no more than simple aspiration. As the fluid reaccumulates, it may be removed as necessary by paracentesis. In rare instances, a hyperplastic form of tuberculosis such as is occasionally seen in the cecum, may involve the small intestine. A lesion of this type should be resected and end to-end anastomosis performed.

Abdominal Actinomycosis

Operation should not be performed for this disease except to drain a large abscess or relieve an obstruction. In spite of the very extensive abdominal adhesions that are present, obstruction is rare and its release is a difficult task. To make one's way through the dense adhesions and multiple small abscesses that are encountered must be a painstaking and time-consuming procedure. If one is fortunate, a collapsed loop may be followed up to a point of constriction but if this is not possible an enterostomy may be performed in a distended loop as near as possible to the obstructed area, with the hope that medical treatment will eventually cause the obstruction to be relieved. If a large abscess is present, it

Paralytic Ileus

No direct surgical attack on this condition is indicated. The Miller Abbott or Wangensteen suction tube should be used to control distention.

TECHNIQUE

Enterostomy

When a tube inserted into the intestine is to be used for feeding purposes, it may be of fairly small caliber about #16 French, but when the catheter is intended to decompress a segment of distended bowel it should be larger about #20 French is most satisfactory An enterostomy the purpose of which is to keep up the nutrition of the patient, should be made high in the jejunum, but in intestinal obstruction the tube should be inserted into the nearest healthy bowel above the point of obstruction. An enterostomy tube inserted high in the bowel for drainage causes loss of the intestinal juices, with depletion of the body fluids and chlorides and should be dispensed with as soon as possible.

Stamm Method A loop of bowel is brought into the incision and its contents are squeezed out by running the thumb and finger along the intestine. The two limbs of the intestine are isolated by a rubber-covered Doyen clamp and a pursestring suture of 00 chromic catgut is inserted on the antimesenteric side of the bowel. The diameter of the circle made by the pursestring should be about twice that of the catheter The bowel

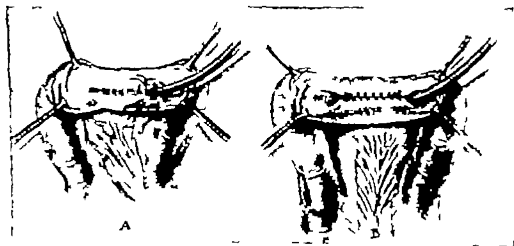


FIG. 129 *Enterostomy* A. *Stamm Method.* A pursestring suture has been inserted in the bowel, and through a stab wound in the center of the pursestring suture a catheter has been introduced. One bite of this suture passes through the wall of the catheter A second pursestring suture, shown diagrammatically here, is inserted and tightened as the catheter is pushed inward to invaginate the first pursestring. B *Witzel Method.* A catheter has been inserted into the bowel and held in place by a pursestring suture. The catheter is then pushed back against the bowel and buried by suturing the wall of the bowel over it.

Anomalies of the Bowel

Congenital stricture or failure of development of a portion of the intestine should be treated by making an anastomosis, preferably of the lateral type, between segments of the bowel above and below Abnormalities of the position or development of the intestine produced by abnormal rotation do not require surgical treatment unless they cause bowel obstruction. It should be remembered that the object of the operation is not to place the bowel in its normal position but simply to relieve the obstruction, and in order to do this a lateral anastomosis is frequently necessary If one can find dilated bowel and collapsed bowel not too far apart, such an anastomosis may save the patient s life and avoid the prolonged and difficult exploration necessary to figure out which particular anomaly one is dealing with.

Wounds and Perforations

Any opening in the wall of the intestine whether it has occurred as a result of the perforation of a typhoid or tuberculous ulcer or has been produced by a bullet or stab wound, should be located and closed by two layers of suture in a direction at right angles to the direction of the bowel. If the bowel wall or mesentery is badly damaged, it may be better to resect that area and perform an anastomosis. Direct blows on the abdomen such as a kick, may produce extensive tearing of the bowel and mesentery and cause massive soiling of the peritoneal cavity but if the bowel can be closed without constricting its lumen too much, it is better to do so than perform a resection. If it is necessary to make an anastomosis in the presence of much infection, the lateral type is to be preferred.

Fecal Fistula

If the fistula is present in an operative incision and shows no tendency to close under a non-operative regime, the incision should be reopened and the tract followed down to the bowel. As soon as the peritoneal cavity is entered, the normal intestine should be protected by moist packs. The fistulous tract is then cut off and the opening in the bowel is closed by two layers of sutures at right angles to the direction of the bowel. After the intestine has been closed the area should be thoroughly washed off with normal saline, the packs removed, and the abdominal cavity investigated to be sure that no foreign body is present. A portion of the omentum is arranged around the sutured bowel before it is replaced. The higher in the bowel the fistula is located, the more difficult it is to close and, in the case of a duodenal fistula, operation should be performed only as a last resort.

through the mesentery to grasp about 1 cm. of tissue A similar hemostat is inserted on the other side of the opening, thus clearing about 2 cm. of bowel from its mesentery It is impossible to make a satisfactory anastomosis unless the mesentery is removed from the portion of bowel to be sutured but the suturing should be so planned that when it is completed the mesentery will extend precisely to the line of anastomosis. Starting from the opening in the mesentery already made, other hemostats are used to clamp progressively on each side of a line in the general direction of the posterior mesenteric attachment. A rubber-covered Doyen clamp is now put on the intestine on the healthy side of the area, where the mesentery was stripped from the bowel On the diseased side, a heavy hemostat or small Payr clamp is applied far enough away from the Doyen clamp so that there will be at least 1 cm. of intestine protruding beyond the Doyen clamp A similar procedure is done at the other end of the area to be resected, and a V-shaped area of mesentery will be excised with the bowel (Figure 130) It is not necessary to make this V extend very far

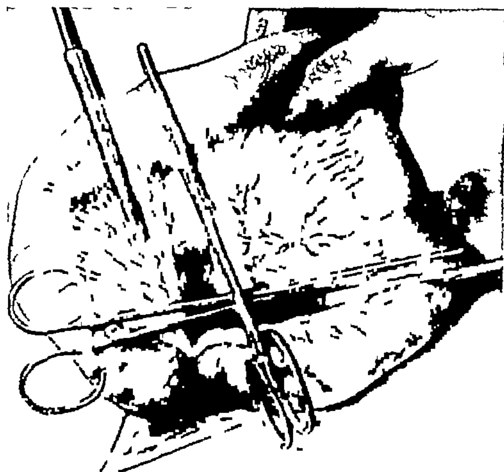


FIG. 130. *Resection and End-to-End Anastomosis* The mesentery has been divided so as to remove a V-shaped segment. Rubber-covered clamps have been applied to the good bowel and hemostats to the loop to be removed. The dotted line indicates the line of incision.

is surrounded by moist packs. Steadying the intestine if necessary with two Allis forceps a stab wound is made in the center of the pursestring and a catheter which has had an extra eye cut in it is inserted into the bowel about 2.5 cm. The needle attached to the pursestring suture is now passed through the wall of the catheter and, as the pursestring suture is tightened and tied the catheter is anchored in place. The ends of the suture are cut and another pursestring suture about .5 to 1 cm. outside the first one is introduced (Figure 129A) As this suture is tightened, the catheter is pushed into the bowel so that the first pursestring becomes invaginated. If the bowel is dilated, another similar pursestring suture may be inserted, but in ordinary cases two are sufficient. A stab wound is now made in the abdominal wall lateral to the incision, a pair of forceps is inserted into the abdomen through this the end of the catheter is grasped and it is brought out, pulling the intestine snugly against the parietal peritoneum. No sutures are necessary or advisable between the intestinal wall and the peritoneum, but the catheter may be passed through the omentum as an aid to the sealing off of the intestinal wound after the catheter has been withdrawn. A single stitch of dermal or silk is now placed in the skin edges of the stab wound, and after it is tied it is passed around the catheter and tied once more.

Witzel Method The intestinal loop is isolated and emptied as described above. The Doyen clamp is applied and a single pursestring suture is inserted in an area opposite the mesenteric attachment. A stab wound is made in the center of the pursestring suture, and the catheter is inserted and held in position by passing the needle of the pursestring through the wall of the catheter before the suture is tied. The catheter is now laid down on top of and parallel to the intestine and, using 00 chromic catgut on a straight needle, the intestinal wall is sutured around the catheter by continuous or interrupted Lembert stitches, so that the catheter comes to lie in a tunnel along the intestine for a distance of from 3 to 5 cm. (Figure 129B) These sutures pass through only the outer layers of the intestine The end of the catheter is brought out through a stab wound and treated as described above.

Resection and End-to-End Anastomosis

The loop of bowel to be resected is brought out on the abdominal wall and surrounded by moist packs. One should be certain that the resection is extensive enough to include all the diseased intestine because if an anastomosis is made between portions of damaged bowel leakage will invariably occur It is always better to take too much intestine than not enough. The loop of bowel is held up by the assistant and a small opening is made through the mesentery directly adjacent to the intestine at a point which will represent the distal or proximal end of the resected area. With one blade of a hemostat in this opening, the other blade is pushed

through the mesentery to grasp about 1 cm. of tissue. A similar hemostat is inserted on the other side of the opening thus clearing about 2 cm. of bowel from its mesentery It is impossible to make a satisfactory anastomosis unless the mesentery is removed from the portion of bowel to be sutured, but the suturing should be so planned that when it is completed the mesentery will extend precisely to the line of anastomosis. Starting from the opening in the mesentery already made other hemostats are used to clamp progressively on each side of a line in the general direction of the posterior mesenteric attachment. A rubber-covered Doyen clamp is now put on the intestine on the healthy side of the area where the mesentery was stripped from the bowel. On the diseased side, a heavy hemostat or small Payr clamp is applied far enough away from the Doyen clamp so that there will be at least 1 cm. of intestine protruding beyond the Doyen clamp A similar procedure is done at the other end of the area to be resected, and a V shaped area of mesentery will be excised with the bowel (Figure 130) It is not necessary to make this V extend very far

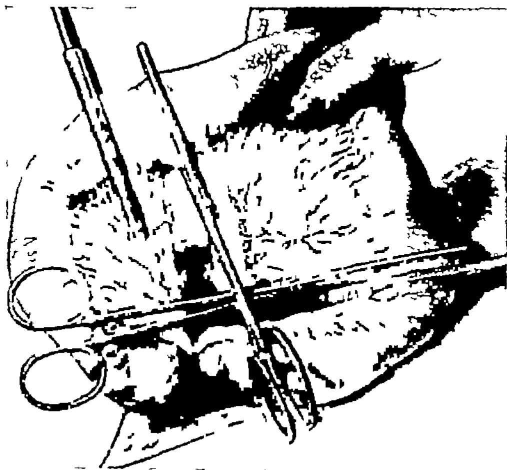


FIG. 130. *Resection and End-to-End Anastomosis* The mesentery has been divided so as to remove a V-shaped segment. Rubber-covered clamps have been applied to the good bowel and hemostats to the loop to be removed. The dotted line indicates the line of incision.

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Resection and End to-End Anastomosis

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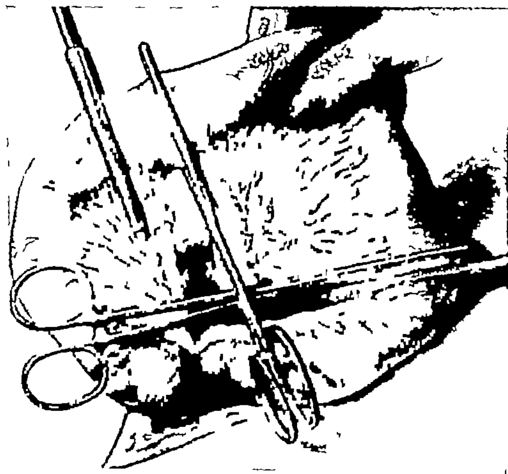


FIG. 130 *Resection and End-to-End Anastomosis* The mesentery has been divided so as to remove a V-shaped segment. Rubber-covered clamps have been applied to the good bowel and hemostats to the loop to be removed. The dotted line indicates the line of incision.

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Witzel Method The intestinal loop is isolated and emptied as described above. The Doyen clamp is applied and a single pursestring suture is inserted in an area opposite the mesenteric attachment. A stab wound is made in the center of the pursestring suture, and the catheter is inserted and held in position by passing the needle of the pursestring through the wall of the catheter before the suture is tied. The catheter is now laid down on top of and parallel to the intestine and, using 00 chromic catgut on a straight needle, the intestinal wall is sutured around the catheter by continuous or interrupted Lembert stitches so that the catheter comes to lie in a tunnel along the intestine for a distance of from 3 to 5 cm. (Figure 129B) These sutures pass through only the outer layers of the intestine. The end of the catheter is brought out through a stab wound and treated as described above.

Resection and End-to-End Anastomosis

The loop of bowel to be resected is brought out on the abdominal wall and surrounded by moist packs. One should be certain that the resection is extensive enough to include all the diseased intestine, because if an anastomosis is made between portions of damaged bowel, leakage will invariably occur It is always better to take too much intestine than not enough. The loop of bowel is held up by the assistant and a small opening is made through the mesentery directly adjacent to the intestine at a point which will represent the distal or proximal end of the resected area. With one blade of a hemostat in this opening the other blade is pushed

together An opened gauze sponge to which a hemostat is attached is placed between the clamps and they are surrounded by clean moist packs. Using 00 chromic catgut on a curved or straight intestinal needle, and

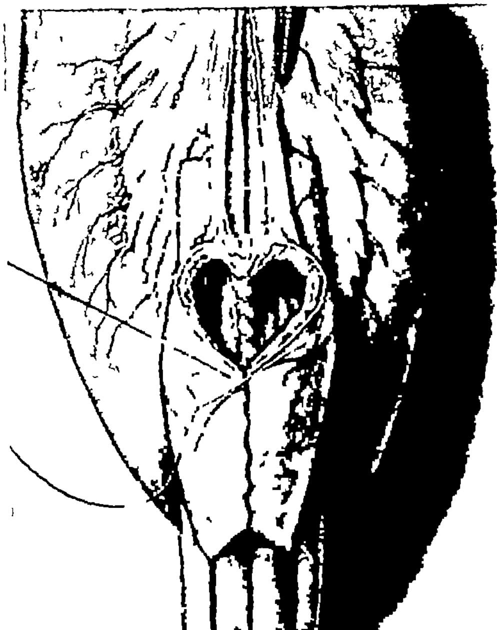


FIG. 132. *Resection and End-to-End Anastomosis* The suture is being continued anteriorly as a Connell stitch. It will be tied to the original end, which was left long.

starting at the end away from the surgeon, the adjacent posterior walls are brought together by a running stitch, which takes in all the layers of intestine (Figure 131) When this stitch reaches the edge of the intestine nearest the surgeon it is locked and continued back to its starting point as a Connell suture (Figure 132) It is tied to the original end, which has

away from the intestine unless one is dealing with a malignant tumor of the bowel. If a deep resection of the mesentery is performed, one must be careful not to cut a major artery supplying an extensive area of intestine. By use of a knife, the intestine is severed between the two sets of clamps and removed, and the two rubber-covered clamps are brought

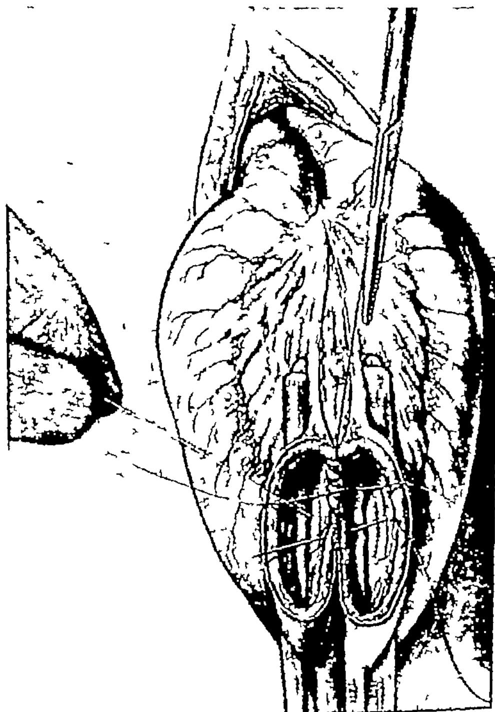


FIG. 131 *Resection and End-to-End Anastomosis* The rubber-covered clamps have been brought together and the first line of sutures, which passes through all the layers, is being inserted.

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FIG. 132. *Resection and End-to-End Anastomosis.* The suture is being continued anteriorly as a Connell stitch. It will be tied to the original end, which was left long.

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been left long and marked by a hemostat. The clamps are now
and a second layer of sutures is inserted around the circumferen
bowel by the Lembert method (Figure 133) particular care be
to invert all mucosa and to secure close approximation at the m



FIG. 133 *Resection and End-to-End Anastomosis* A serosal stitch h
started above and will continue around the anastomosis and, comb
posteriorly it will be tied to the end, which was left long The openin
mesentery will be closed by a few interrupted sutures.

border In making an end to-end anastomosis, one should always
ful not to pull the sutures too tight and not to invert so much of th
that the lumen is extensively encroached upon. When an anasto
to be performed between two ends of bowel that are dispropo
in size, the smaller end may be cut diagonally so as to give a larg

rupted sutures are now put in to approximate the severed portions of the mesentery and prevent herniation of bowel through the opening

Lateral Anastomosis or Entero-Enterostomy

This operation may be used as a short-circuiting procedure or as a method of re-establishing the continuity of the bowel after the cut ends of intestine have been closed. When the bowel is sectioned, small Payr clamps or heavy hemostats are used in place of the Doyen clamps. The bowel is cut off close to the clamps and the ends are closed by the method described for use on the duodenal stump A straight or curved intestinal needle with 00 chromic catgut, is passed through the edge of the bowel just under the clamp and at the point away from the surgeon. The end of this suture is held with a hemostat and not tied. The suture with the needle is now brought over the clamp and used to take a bite through the outer layers of the bowel. It then passes over the clamp to the opposite side, where a similar bite is taken. This process is continued until the edge of the bowel nearest the surgeon is reached. These stitches should be taken about .5 cm. away from the clamp to assure satisfactory inversion of the stump The assistant now grasps the end of the suture to which the hemostat was attached the surgeon holds the needle end, and, as the hemostat is loosened and gradually withdrawn, tension made on the two ends of the suture will bring the serosal surfaces together (Figure 134A) The suture is locked and continued back to its starting point, giving an additional layer of Lembert suture for reinforcement (Figure 134B) This procedure is repeated on the other end of the intestine and, when it is completed, the two ends of the bowel are brought close together rubber-covered Doyen clamps are applied to each just above the closed end and in a direction parallel to the bowel along the antimesenteric surface. The Doyen clamps should be applied so that most of the intestine protrudes above the clamp and about three finger breadths of the bowel are included in the clamp It is also more convenient if the clamps are put on with the handles pointing distally on the bowel, so that they can be brought together in making the anastomosis. An opened gauze sponge with a hemostat attached is placed between the clamps the adjacent rubber coverings are fastened together with a hemostat and moist gauze packs are arranged around the field. Starting at the point away from the surgeon, assuming that the handles of the clamps are pointing toward him, a straight or curved intestinal needle on 00 chromic catgut is used to insert a continuous Lembert stitch uniting the outer layers of the bowel together (Figure 134C) The end of this suture is tied and left long, and marked with a hemostat. When the suture reaches the point nearest the surgeon, it is locked, laid down, and covered with a pack. By use of a knife a short linear opening is made in one limb of the intestine near the suture line and through this the point of a pair of scissors is in-

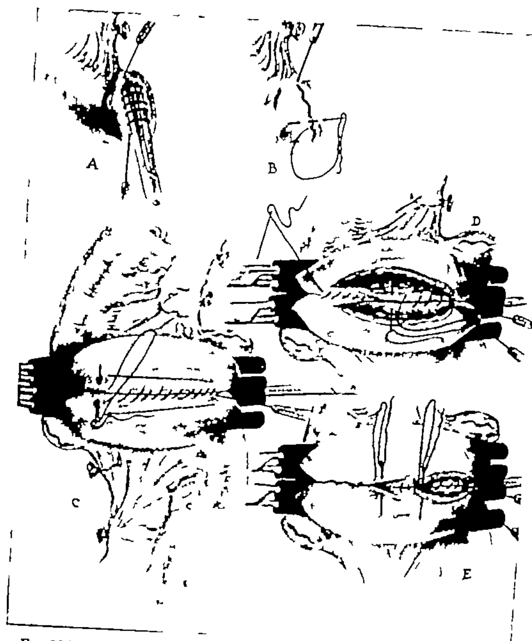


Fig. 134. *Closure of the Ends of the Bowel and Lateral Anastomosis* A. Sutures have been applied over a clamp, and as the clamp is removed, the sutures are tightened. B. A second line of sutures is being put in to reinforce the closure. C. Rubber-covered clamps have been applied and approximated. The first or serosal layer of sutures is almost complete, and the lines of incision are indicated by dots. D The incisions have been made and the second posterior row of sutures, which pass through all layers, is being inserted. E. The posterior suture is being continued back anteriorly as a Connell stitch, and it will be tied to the end left long. Following it is a serosal stitch, which is a continuation of the stitch shown in C. It will be tied to the original end, which was left long

serted and the incision is lengthened to at least two finger breadths. A
the intestinal contents which may have exuded are sponged away
similar incision is made in the other limb of bowel. Now starting at
point away from the surgeon, a continuous running stitch is put in u
ing all the layers of the posterior surface of one segment of bowel
similar layers of the other (Figure 134D) The original end of this sutu
after it has been tied, is left long and marked with a hemostat. When
suture reaches the point nearest the surgeon it is locked and contin
back as a Connell suture of the anterior layers of the bowel (Fig
134E) When it reaches its starting point it is tied to the original sutu
Before this suture is completed it is advisable to loosen the clamps a
inspect the anastomosis, and if any bleeding points are seen they
caught with a fine hemostat and tied, or a mattress stitch may be ma
in that region. The anastomosis is now washed with normal saline solut
and the packs are removed. The original needle is taken up and contin
back to its starting point as a Lembert suture (Figure 134E) where i
tied to the end that was left long The gap in the mesentery is clo
with a few interrupted stitches.

Exteriorization of Bowel

The loop of bowel to be exteriorized is brought out of the abdom
the two limbs of the intestine are approximated, and the peritone
fascia, and skin are closed snugly around them. Care should be taken
to make the opening so tight as to obstruct the lumen or the blood s
ply of the bowel. In the majority of cases the intestine can be delive
out of the abdominal wall without tension, and probably no stitches
necessary to hold it in place, but it is a little safer to use a few interrup
stitches between the outer layers of the bowel and the peritone
Enough of the intestine should be brought out to allow at least 3 or 4 c
of normal bowel on each side of the diseased loop to project from
skin. The entire mass is surrounded by vaseline.

If the exteriorized bowel is not viable, at the expiration of a few hour
or immediately if necessary — a puncture wound is made in the heal
projecting portion of the proximal limb and a catheter is inserted to p
mit the passage of gas and bowel content. This catheter can usually
held in place by a pursestring suture, and aids in avoiding contaminat
of the wound for a period of time. At the end of seventy two hours
more the gangrenous segments of the bowel may be cut off with knife
cautery The resulting double-barreled enterostomy is later dissected f
from the abdominal wall and closed by one of the methods of ente
anastomosis described above.

If the limb of bowel brought out on the abdomen is viable, when t
patient's condition improves or at the expiration of about a week, t

abdominal wound may be reopened and the intestine returned to the dominal cavity

In order to avoid this second operation, at the time the loop of b is brought out on the abdominal wall the Mikulicz procedure ma used. The two limbs of bowel are sewed together for a distance of t to four finger breadths on the mesenteric and antimesenteric bor using continuous or interrupted sutures of catgut. The peritoneum abdominal wall are closed around the limbs of bowel so that the a sutured together are in the abdominal cavity and abdominal wall. treatment of the exteriorized loop of bowel is the same as that menti in the previous discussion, but the resulting double barreled enterost is different, in that one may at the expiration of a week or more insert blade of a special crushing clamp or heavy Ochsner forceps into limb of the intestine and by gradually tightening the clamp by mean a rubber band wrapped around the handle, the spur between the limbs of bowel is caused gradually to necrose and slough. The inte current can then pass from the upper to the lower limb without going on the abdominal wall and in many cases the enterostomy closes sp taneously If the first bite made by the clamp does not cause destruc of the spur deeply enough, the clamp can be applied again farther Exploration with the finger and this is helpful also in applying the cla will ascertain the situation.

If the exteriorized bowel is obviously not viable the foregoing p cedure may be modified by applying a clamp to the lower loop cutt it off and, after cutting off the upper loop, tying a glass tube or la caliber catheter in the lumen. The clamp on the lower limb is remo at the end of seventy two hours or when it sloughs off If it is prefer to leave the necrotic bowel in place for a day or two a stab wound m be made and a catheter inserted into the upper limb of the intestine held in place with a pursestring suture.

If one does not wish to put a tube in the exteriorized bowel, an in pendent enterostomy may be made in a portion of the bowel above exteriorized loop and the catheter brought out through a stab wound

Removal of Diverticulum

A hemostat is applied to the base of the diverticulum at right angles the axis of the bowel, and the diverticulum is cut off with a knife cautery With a straight intestinal needle and 00 chromic catgut, a n ning stitch is put in below the clamp The clamp is then removed, t crushed tissue cut off almost to the suture line, and another continuo stitch of the Lembert type is inserted to invert the first layer of sutur

POSTOPERATIVE CARE

If there has been no resection of the bowel fluids are allowed in small amounts as soon as nausea has subsided. If bowel was resected, nothing is given by mouth until peristalsis has been established, usually after forty-eight hours During this time continuous suction is maintained by the Wangensteen apparatus and a Levine tube in the stomach. Adequate fluid intake is provided, along with chlorides, proteins, and glucose and transfusions are given freely if there has been loss of blood in a strangulated segment of bowel. If an enterostomy tube has been inserted, it is connected to a bottle and sterile water injected into it occasionally to keep it from becoming plugged. If the enterostomy is located high in the small bowel the intestinal discharges tend to excoriate the skin and if there is any leakage around the tube the skin should be protected by an ointment. I use a zinc oxide paste containing aluminum powder During the postoperative period, morphine should be administered as necessary for pain, and enemata and the rectal tube help in preventing distention. Penicillin is given if there has been peritoneal soiling or if there is evidence of infection.

CHAPTER XIX

The Appendix

PREOPERATIVE PREPARATION

INCISION

EXPLORATION

LESIONS OF THE APPENDIX
- Acute Catarrhal Appendicitis
- Acute Diffuse Appendicitis
- Gangrenous Appendicitis
- Perforation of the Appendix
- Acute Obstruction of the Appendix
- Peri Appendicitis
- Chronic Recurring Appendicitis
- Chronic Appendicitis
- Foreign Bodies in the Appendix
- Carcinoid Tumor
- Actinomycosis
- Tuberculosis
- Carcinoma and Other Rare Tumors of the Appendix
- Mucocele of the Appendix
- Localized Peritonitis
- Appendiceal Abscess

TREATMENT

TECHNIQUE
- Appendectomy
- Drainage of Appendiceal Abscess
- Surgical Procedure in Generalized Peritonitis
- Fecal Fistula

POSTOPERATIVE CARE

The Appendix

Operation for removal of the appendix is the most common major su
gical procedure. Usually the operation is simple and easy but sometin
it is so difficult as to tax the skill and judgment of the most experienc
surgeon.

PREOPERATIVE PREPARATION

In acute appendicitis no special preoperative measures are necessa
other than the usual preoperative medication and preparation of the ski
but a complete physical examination with a blood count and urinaly
should be performed. When operation is being done for an appendice
abscess or for chronic appendicitis, there is ample time to correct an
fluid or electrolyte deficiency and this should be done before surger
An enema should also be given on the evening before operation, bu
no preoperative enema should be ordered for the patient having acu
appendicitis

INCISION

When there is no doubt about the diagnosis, the McBurney incision
most satisfactory since it gives a direct approach to the appendix an
leaves a strong abdominal wall. A transverse incision may be used, how
ever if preferred. When there is any question about the diagnosis, an
this includes almost all cases of chronic appendicitis, a right rectus c
paramedian incision will permit more satisfactory exploration and ca
be extended upward or downward. In women, when there is a possibilit
that one may have to deal with the adnexa on the left side, it is well t
make the incision near the midline.

EXPLORATION

When the peritoneum is opened, one should note particularly whethe
there is an excess of fluid present, since such a finding will denote peri

toneal irritation from some source and the operation should not be con cluded until its cause has been found. By lifting and pulling outward on the lateral edge of the incision the cecum can usually be seen at its at tachment along the posterior and lateral abdominal wall in the right lower quadrant. It should be grasped with toothless thumb forceps and drawn out of the incision where it can be held by the assistant after it is covered with a piece of moist gauze. If it cannot be seen, a finger is in serted into the abdomen and the fixed cecum or ascending colon is hooked and pulled up into the wound The longitudinal bands and thin bowel wall give the colon a characteristic structure which can be detected by the finger If the ascending colon is brought up it is followed downward to the cecum and then replaced into the abdomen. In the event that the cecum or appendix cannot be located a loop of ileum, which usually oc cupies the right lower quadrant, may be drawn out on the surface and, using the technique described under intestinal localization, the ileum can be followed distally until it goes into the cecum but this maneuver should be avoided if possible After the cecum has been identified, the appendix is located by following down the longitudinal bands that lead to the base of the appendix. From its more or less fixed point on the cecum, the appendix may extend in almost any direction. The most common location for it is medial to the cecum, but not infrequently it hangs over the brim of the pelvis or passes upward along the lateral wall of the cecum, where it is commonly covered by peritoneum It may also be behind the cecum and entrely invisible until the cecum is rolled medially after cutting its lateral peritoneal attachment.

If acute inflammation is found to be present in the appendix, no gen eral abdominal exploration should be conducted, but when the con dition of the appendix is not sufficient to explain the findings and symptoms and in all cases of chronic appendicitis, other abdominal organs should be explored. Peritoneal irritation as evidenced by an excess amount of peritoneal fluid or the presence of serofibrinous exudate necessitates a most thorough search for its cause. In women, the most common site of inflammation when appendicitis has been ruled out is the tubes and ova ries. Acute salpingitis chronic salpingitis, and pelvic peritonitis, a ruptured ovarian follicle or an ovarian cyst with a twisted pedicle may be present. It may be desirable to treat the chronic salpingitis by removal of tured ovarian follicle, or an ovarian cyst with a twisted pedicle may be extended downward and medially by cutting through the anterior rectus sheath and retracting or cutting the rectus muscle toward the midline. The removal of the left tube through such an incision is an awkward procedure at best, and the necessity for doing it should be avoided by mak ing the proper incision in the first place. The treatment of acute salpin gitis is not surgical If an ovarian cyst is present, it should be removed. If the pelvic organs are normal, the gallbladder should be investigated.

Acute cholecystitis is usually associated with tenseness and thickening of the walls of the gallbladder and there may be fibrinous adhesions in the neighborhood of the gallbladder The exploring hand should next pass over the stomach, searching for areas of induration or adhesions. Thickening of the head of the pancreas should be sought for and the size of the spleen determined. The hand may now be passed back over the dome of the liver searching for irregularities or roughness of its surface. The size and shape of the kidneys should be determined. If all these areas show negative findings, a search should be made for Meckel's diverticulum. Inflammation of an epiploic appendage may occur alone or in association with appendicitis, and this should be watched for The coils of intestine should be investigated for areas of induration, adhesions, or a point of fixation, which may mean obstruction non-specific ileitis, or intra-abdominal hernia. Having concluded the abdominal exploration, if it is found necessary to approach the upper abdominal viscera, the appendix is removed and the right rectus or paramedian incision is extended upward and any indicated operation performed. If by mistake, a McBurney incision has been used, it should be closed and an upper abdominal incision made.

LESIONS OF THE APPENDIX

Acute Catarrhal Appendicitis

This is a type of appendicitis in which the inflammation is confined to the mucosa. It is of only theoretical interest.

Acute Diffuse Appendicitis

In the early stages the appendix feels firmer than normal and shows congestion of the blood vessels. Later the organ is considerably enlarged, reddened, and may be either firm or distended with pus. Concretions are commonly present in the lumen. The surface is often covered with a purulent exudate, and the appendix may be adherent to neighboring coils of bowel

Gangrenous Appendicitis

This is the final stage in acute diffuse appendicitis and is due to interference with the blood supply of the organ The circulatory disturbance is due to extension of the inflammation to the meso-appendix, with thrombosis of the vessels, or to the edema and inflammation in the appendix itself Usually gangrene takes place near the tip and extends proximally but sometimes two or more areas of gangrene in various parts of the organ may be present. Frequently the necrosing process extends into the meso-appendix and sometimes into the cecum.

Perforation of the Appendix

This may occur in acute diffuse appendicitis or in the gangrenous type, and the perforation may be a minute pin sized opening or may be a large irregular hole Not infrequently a perforation is sealed over by omentum.

Acute Obstruction of the Appendix

This may be due to a fecal concretion in the lumen or to kinking of the appendix, or to localized inflammation near the proximal end. The damming up of mucous secretion in the appendix with subsequent infection results in any of the types of appendicitis mentioned above

Peri Appendicitis

Usually as an extension of inflammation from elsewhere, commonly the tubes, the outer coats of the appendix may become inflamed and take on the appearance of acute diffuse appendicitis.

Chronic Recurring Appendicitis

In this condition the patient has recurring attacks of appendicitis, and if the operation is done in an interval between the attacks, nothing abnormal may be apparent grossly Sometimes the appendix is seen to be bound down by adhesions that are the result of previous inflammation and sometimes the appendix is thicker than normal and when rolled between the fingers gives a sensation of firmness; but acute inflammatory changes are seen only when the operation is performed at a time when symptoms are present.

Chronic Appendicitis

This condition is in many instances a functional rather than a pathologic disease of the appendix. In many cases, no evidence of inflammation can be seen. Sometimes the result of previous inflammation will be apparent, and sometimes fecoliths will be present in the lumen. Often obliteration of the lumen will be present to a greater or less degree and occasionally white scarred areas or deformity or kinking of the appendix may be evident.

Foreign Bodies in the Appendix

Mention has already been made of the presence of fecal concretions in the lumen of the appendix. Less commonly foreign bodies of various kinds such as grape seeds bristles pin worms, and fruit stones, may be seen. It is probable that none of these is an important factor in the causation of acute appendicitis but, if inflammation should set in the presence of a foreign body in the lumen may predispose to obstruction and circulatory disturbance

Carcinoid Tumor

This is a not uncommon benign tumor of the appendix. It most frequently develops near the tip of the appendix and appears as a firm, rounded enlargement which on section shows a yellow ring in the region of the submucous coat. The tumor may also be encountered in the small intestine but there it is malignant and metastasizes to the regional glands and liver

Actinomycosis

This disease may develop primarily in the appendix, and apparently in the early stages it is indistinguishable from acute appendicitis in gross appearance When it involves the cecum, there may be adherence to surrounding coils of bowel with small pockets of pus between the loops of bowel. In these abscess cavities careful inspection may reveal the typical sulphur granules. They are about the size of the head of an ordinary pin and are yellowish or yellowish gray in color

Tuberculosis

This is rarely primary in the appendix, but is more often due to an extension from the Fallopian tubes or the cecum. There may be diffuse enlargement of the appendix, and tuberculous nodules may be apparent on the surface or in the meso-appendix.

Carcinoma and Other Rare Tumors of the Appendix

Carcinoma is seldom seen but has the appearance of carcinoma elsewhere and metastasizes to the mesenteric glands. Sarcoma, lipoma, neuroma, endothelioma and adenoma have been reported.

Mucocele of the Appendix

Occasionally as a result of obstruction of the appendix near the cecum, the lumen of the appendix becomes dilated by the secreted mucus and takes the form of a cyst. Such a cyst is usually small but occasionally may reach large size. The contents are thick and mucoid in character

Localized Peritonitis

Following rupture of the appendix or as an extension of inflammation from the appendix, the neighboring coils of bowel are involved and there is roughening of their peritoneal covering and deposition of fibrin and muco-purulent exudate. The coils of bowel may appear normal in the early stages, but later they are reddened and roughened, and the peritoneal coat loses its sheen. Loops of intestine may be adherent but they are easily separated without leaving a bleeding surface. The exudate is usually large in amount and may have a foul odor

Appendiceal Abscess

Rupture of an acutely inflamed appendix may be followed by the formation of a localized abscess, if the location of the appendix and the resistance of the patient are favorable. Such an abscess is most commonly located in the right lower quadrant in the region of the appendix but may be found in the pelvis or elsewhere It is surrounded by coils of intestines glued together by fibrin and has no definite wall until it has been present for a considerable length of time The content is thick pus, which may or may not have an odor depending on the predominant type of organism.

TREATMENT

In any form of appendicitis, appendectomy should be performed with the least possible handling and contamination of intraperitoneal structures. When an abscess is present due to rupture of the appendix the latter should be removed only when it is accessible without prolonged search and extensive separation of adherent coils of bowel. In many cases the surgical procedure should be reduced to the minimum, which consists of merely draining the abscess. Mucocele of the appendix is cured by removal of the appendix, but in removing it care should be taken not to rupture the cyst, since the mere spilling of the contents may be sufficient to start the condition known as pseudomyxoma peritonei A carcinoid tumor of the appendix is removed by appendectomy In the rare case of carcinoma of the appendix, if the tumor is limited to the appendix itself simple appendectomy is done. If the tumor has extended to the cecum or to the mesentery resection of the appendix and ascending colon and wide removal of the mesenteric glands are indicated if there is no metastasis elsewhere. Actinomycosis when confined to the appendix, will probably not be recognized as such, but the treatment for it is removal of the appendix. If the nature of the disease is evident and the process has extended to the cecum, no surgical procedure should be done unless there is an abscess that can be drained. A tuberculous appendix should be removed even though a fistula may follow If extension has taken place to the cecum, excision of the mass should be done only if it is of the hyperplastic type that tends to cause enlargement of the cecum with obstruction.

TECHNIQUE

Appendectomy

Having drawn the cecum into the wound (Figure 135) the finger may be inserted into the abdominal cavity to search for the appendix. The acutely inflamed appendix will be evident as a firm elongated mass, which

FIG. 185 *Appendectomy* The cecum has been grasped and is being drawn out of the wound.

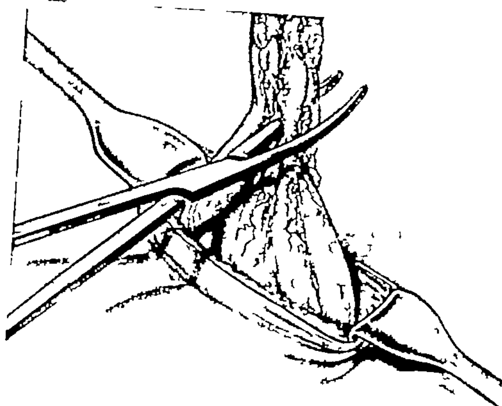


FIG. 186. *Appendectomy* While the appendix is held up a hemostat is applied to the meso-appendix.

may or may not be adherent to neighboring coils of bowel. When such fibrinous adhesions are present they are gently separated with the fingers and the tip of the appendix is worked upward to a point where it can be caught. A hemostat should not be applied to the appendix itself but its mesentery is grasped, or an Allis forceps is applied around the appendix.

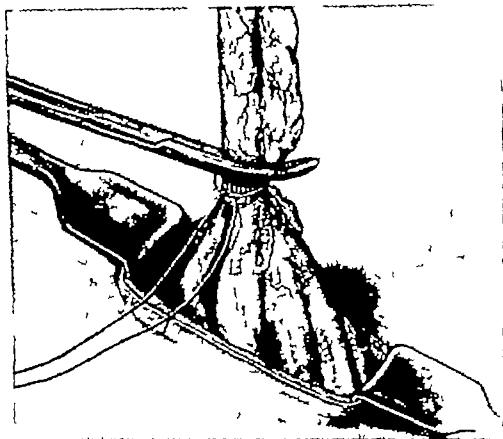


FIG. 137 *Appendectomy* The appendix has been clamped near the cecum, and the clamp has then been moved upward and reapplied A ligature is ready to be tied around the previously crushed region of the appendix

While the organ is held up the mesentery is clamped and cut (Figure 136) If the mesentery is thick or inflamed, it should be clamped and cut in segments, care being taken not to cut too close to the clamp because such a mesentery may retract and slip out of the instrument. Section of the mesentery is continued to the base of the appendix at the cecum, and when the mesentery has been freed, a clamp is applied to the base of the appendix tight enough to crush it. The clamp is then moved upward about .5 cm and reapplied (Figure 137) The groove where the clamp was first applied is now tied with 0 chromic catgut, using care not to pull the ligature so tight as to cut through. The appendix is laid aside and the mesentery is ligated as the clamp or clamps on it are removed. The assistant then holds the appendix upright with one hand, by means of the

hemostat attached to the mesentery near the tip of the appendi
the other hand he steadies the hemostat near the base of the ap
A sponge is arranged around the base of the appendix over the ceca
the appendix is cut off about 3 mm. above the ligature (Figur
This may be done with the cautery or with the scalpel If the latter
a small amount of phenol is applied to the stump of the appen

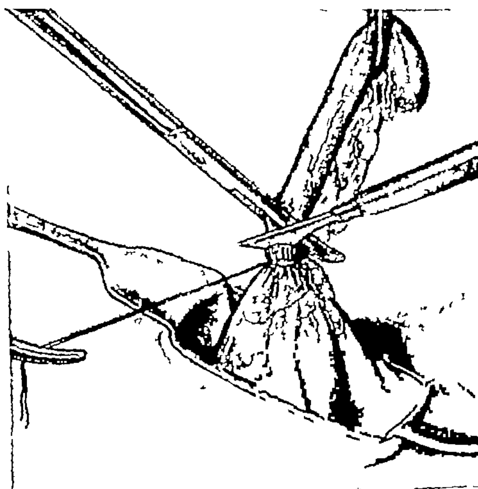


FIG. 188 *Appendectomy* The appendix is being cut off between the li
and the hemostat.

lowed by alcohol and the excess fluid is squeezed out of the stu
pressure with a sponge held in a toothless forceps The appendix a
hemostats attached to it are placed in a pan along with the contam
knife and sponges. After the mesentery has been inspected to b
that there is no bleeding, the operation may be concluded at this
the cecum dropped back into the abdomen, and the wound closed.
seen no complications that could be attributed to this technique.

Two other methods of dealing with the appendix stump are in g
use both of them involving inversion of the stump into the cecum

pursestring suture around the base of the appendix. In the method of ligation and inversion the stump is ligated as has been described, but before the appendix is cut off a pursestring suture of 00 chromic catgut on a curved intestinal needle is inserted about 8 mm. away from the circumference of the appendix. The appendix is then cut off and, after the stump has been phenolized and neutralized with alcohol it is grasped by toothless forceps and, as the pursestring suture is tightened, pushed into the wall of the cecum. A complication occasionally met with when this technique is used is an abscess that develops in the closed pouch in the cecal wall.

Using another method, the stump of the appendix is inverted by a pursestring suture without ligation of the stump itself When the stump of the appendix is not ligated, care should be taken in putting in the pursestring suture to take one bite through the submucosa in the region of the mesenteric attachments at the base of the appendix, so that the blood vessel which commonly lies in this region will be ligated when the pursestring is tied. Two hemostats are now applied one above the other at the base of the appendix and the appendix is cut off between them. The hemostat is removed and the stump is grasped immediately and pushed into the cecum as the pursestring is tightened and tied. After the inversion of the appendix into the cecum the suture line is reinforced by tying a small fat tab such as one of the appendices epiploica or a portion of the meso-appendix, over it. This method is based on sound surgical principles, since it permits the apposition of serous surfaces and leaves no closed pocket in the cecal wall. Unfortunately in many cases the appendix and the cecum itself are so thickened and inflamed that inversion cannot be safely done.

When the appendix lies retroperitoneally it is necessary to cut the peritoneal membrane that covers it before it can be released and the vessels ligated. In many cases it may be impossible to bring up the tip of the appendix sufficiently to identify the mesentery and the appendix must be removed by first severing it from the cecum, as described above, and then working downward, clamping the mesentery as progress is made in freeing the organ (Figure 139) Here care must be taken not to put too much tension on an inflamed and possibly gangrenous organ, or rupture may occur

No drainage is necessary so long as the inflammation is practically confined to the appendix. If the appendix has ruptured, or if its removal is incomplete or accomplished only by extensive and prolonged dissection with probable peritoneal soiling, drainage should be instituted. One Penrose drain may be placed in the pelvis and another along the right lumbar gutter The drains should be brought out along the peritoneal wall and not through loops of bowel.



FIG. 139 *Removal of the Appendix from the Proximal End Outward* This is often necessary when the distal end cannot be immediately freed. The appendix has been cut off at the cecum and the meso-appendix is being divided between clamps.

Drainage of Appendiceal Abscess

When such an abscess is located in the right lower quadrant, drainage can be most satisfactorily done through a McBurney incision, but when the abscess lies in the pelvis, a midline incision is to be preferred. After the peritoneum has been incised and the area packed off with moist gauze the finger is gently inserted along the peritoneum and if necessary between the coils of bowel in the direction of the abscess. As soon as it is entered, pus will pour out along the finger and should be removed by suction. If the appendix can be located without a great deal of difficulty it should be removed. If not, two Penrose drains are inserted and the wound is closed very loosely or not at all. The drains should be left in until

drainage decreases considerably in amount and a drainage tract is well established, which is usually around the sixth or seventh day

Surgical Procedure in Generalized Peritonitis

Here again, if the appendix can be easily located it should be removed otherwise as much as possible of the pus should be removed by suction sulfanilamide may be sprinkled over the bowel, and one or two Penrose drains are inserted to the region of the appendix.

Fecal Fistula

This is a complication not infrequently following appendicitis with rupture The mere presence of a copious foul-smelling discharge, however should not alone lead to the diagnosis of fecal fistula. The discharge must have a fecal appearance and gas must be present before one can be certain that a fistula has occurred. Fecal fistula nearly always closes spontaneously and if it persists longer than six weeks some other condition should be suspected first the presence of a foreign body such as a sponge- second, tuberculosis third, actinomycosis. It should be possible to diagnose the latter two diseases by smears from the pus or scrapings from the wall of the fistulous tract. If these diseases have been ruled out and the fistula shows no tendency to close, reoperation should be done, at which time search can be made for a foreign body If none is found, the opening in the bowel is dissected free from the surrounding structures and closed by a double inverting layer of chromic catgut.

POSTOPERATIVE CARE

In the uncomplicated case of appendicitis, fluids are given by mouth as soon as nausea has subsided, and parenteral fluids are given only if vomiting persists and dehydration is present. The patient is given a soft diet on the third day and a full diet on the fifth day Morphine is given as necessary for pain or restlessness. Breathing exercises and changes of position are encouraged. An enema is given on the third day and after this mineral oil or milk of magnesia are administered as required. In the case of the ruptured appendix, penicillin is given every three hours intramuscularly until the temperature returns to normal. Care is taken that protein and vitamins are provided when the oral intake is inadequate. If vomiting persists, the Wangensteen suction apparatus is used, and fluids are withheld by mouth until peristalsis is established. Low enemata and the rectal tube are used on the third day and following as required. Transfusions of blood or plasma should be used to combat anemia and hypoproteinemia. Drains should be removed when the pus becomes more serous in character usually about the seventh day (See also the treatment of peritonitis in the chapter on The Peritoneum, Retroperitoneal Tissues, and Adrenal Gland.)

CHAPTER XX

The Colon

Tuberculosis
Actinomycosis
Mesenteric Thrombosis and Embolism
Congenital Anomalies
Diverticula
Chronic Ulcerative Colitis
Benign Tumors
Carcinoma of the Colon

TECHNIQUE

Cecostomy
Colostomy
Appendicostomy
Ileocolostomy
Ileosigmoidostomy
Resection and End-to-End Anastomosis
Mikulicz Procedure
Obstructive Resection
Resection of the Cecum, Ascending Colon, and Hepatic Flexure
Removal of Splenic Flexure and Descending Colon
Total Colectomy
Abdominoperineal Resection in One Stage
Lahey Method
The Lockhart Mummery Method
Babcock Bacon Method

POSTOPERATIVE CARE

The Colon

The relatively inaccessible position of most of the large bowel together with the thin walls, highly infective contents, and none too adequate blood supply gives to surgery of the colon an inevitably higher mortality than that of the small intestine. Since carcinoma is the commonest surgical lesion, the usual operation calls for extensive resection and there is the additional hazard of shock and hemorrhage· but the degree of surgical judgment and skill exercised is usually the deciding factor in the outcome of the case.

PREOPERATIVE PREPARATION

Unless there is an emergency the patient who is to have an operation on the colon should have thorough preoperative preparation, including not only preparation of the bowel but study and treatment of the patient as a whole. Many individuals who need surgery of the colon require, because of their age, assessment of the condition of the urinary cardiovascular respiratory and nervous systems. Anemia, dehydration, debilitation, and inanition are common symptoms of carcinoma, the lesion for which surgery of the colon is most often demanded. Partial or complete obstruction of the bowel is often encountered in these cases, and not only should it be relieved as much as possible, but care should be taken that nothing is done to increase it. A period of preoperative study and treatment not only gets the patient in condition for surgery but makes the surgeon better able to determine, when he is confronted with a given lesion whether he should remove it in one stage or by a graded procedure.

Whenever possible, the patient should be admitted to the hospital at least one week before the operation is to be done. During this time his general condition is improved as much as possible, he is given rest in cheerful surroundings, and he should receive encouragement from the surgeon Together with the routine laboratory studies an X ray of the chest should be taken, and electrocardiograms or special kidney function

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studies should be made as indicated. Anemia is combatted by transfusion, and dehydration by venaclysis.

If there is a possibility that an obstructing lesion of the bowel may be present no barium should be given by mouth. If barium has been given, divided doses of milk of magnesia should be administered in the attempt to clear the bowel Barium given by enema should likewise be removed by enemas, milk of magnesia, mineral oil or even a saline cathartic, but no enemas or cathartics should be given on the day before operation. The patient should be placed on a nonresidue diet of high caloric value during his preoperative period, and five days before the operation he should be started on a nonabsorbable sulfonamide by mouth. Succinylsulfthiazole is given in a dose of 0.25 gm. per kilogram of body weight daily The first dose is given all at once, but on subsequent days the dose is divided and given every four hours. A newer drug, phthalylsulfthiazole, or streptomycin may be given orally instead of the succinylsulfthiazole. Both apparently are more effective. After the operation the drug is continued as soon as the patient is able to take it by mouth.

When it seems that a colostomy may be necessary the patient should be told about it, but not in such a way as to overemphasize it. If the patient objects to the operation, the reason for the colostomy is explained and its unpleasantness is minimized as much as can fairly be done.

INCISION

The course of the colon around the abdominal cavity necessitates preoperative knowledge of the location of the lesion before the incision is made, unless the sole immediate objective is to relieve obstruction. Fortunately the chronic nature of most surgical diseases of the colon makes possible a thorough roentgenologic and sigmoidoscopic examination of the patient before operation, and in most cases not only the location of the disease but its nature will be ascertained by these means. When obstruction is present and the distention of the colon is so severe as to demand immediate relief a McBurney incision over the cecum is most satisfactory for the performance of a cecostomy When acute inflammatory changes, such as are seen in diverticulitis have occurred, the symptoms and the usual location of this condition call for a lower left para median or transverse incision. This is the approach used for any part of the descending or sigmoid colon. The type of incision used in the performance of various operations on the colon will be mentioned specifically in connection with the description of the operation.

EXPLORATION

In general, when the abdomen is opened, a systematic examination of the peritoneal cavity is indicated. The presence of excess peritoneal fluid may point to metastatic carcinoma of the peritoneum an acute inflam-

matory lesion tuberculous or other peritonitis, disturbance of the blood supply of a viscus, or a cirrhosis of the liver The hand is inserted into the peritoneal cavity and the distention of the colon or the presence of firm obstructing masses is determined. When the incision is on the right side, the appendix is drawn into the wound and inspected. In the female the pelvic organs are palpated and particular attention is paid to the rectal shelf. The hand is passed up toward the liver noting at the same time the size of the kidneys and the surface of the liver is felt for irregularities that may be indicative of metastasis. If cancerous nodules are found in the liver, on the peritoneum or in the pelvis, any surgery done on the colon must be purely palliative in nature and will be directed solely toward relieving obstruction. An accessible nodule should always be removed for microscopic examination to confirm the diagnosis. The hand passes over the stomach, duodenum, and gallbladder searching for areas of induration or adhesions. Most operations on the colon are of such magnitude that they should not be combined with any other procedure, unless the removal of the lesion of the colon necessitates the removal of an adjacent organ but incidental findings in abdominal exploration may be important in the proper treatment of the patient during convalescence The hand, in passing to the upper abdomen and coming out, should note the condition of the small bowel and the omentum and, if the latter is adherent somewhere in the abdomen, this point should be carefully examined, since it may be the only indication of a lesion. In general lesions of the colon should be handled as little and as gently as possible, since bacteria easily pass through the wall of a diseased and traumatized bowel

LESIONS OF THE COLON

Volvulus

The most common location of volvulus is in the sigmoid colon, where the mesentery is long, but volvulus of a cecum that is not closely attached to the abdominal wall may occur and volvulus of the transverse colon is occasionally seen. A volvulus of the cecum frequently includes in the twisted segment a portion of the lower ileum, and in some of these cases the cecum is provided with a mesentery that is a continuation of that of the ileum. The twisted loop quickly becomes distended with gas and fluid, its blood supply is cut off and it takes on a congested appearance, which soon changes to gangrene. In the early stages the peritoneal fluid may be clear but increased in amount, but in the course of a few hours red-blood cells in larger and larger numbers find their way through the strangulated loop into the peritoneal cavity The bowel above the obstructed loop is distended but normal in color and when the volvulus is in the sigmoid, the distention is at first limited to the colon, where the gas is blocked by the ileocecal valve, but as time goes on it may extend

to the small intestine When the abdomen is opened, the distended loop has a tendency to protrude from the wound. If it does not do so, the large, tense bowel is easily located by the examining hand.

Intussusception

The usual location for intussusception is the ileocecal region, and this has already been discussed under the small intestine (page 381) but intussusception of any part of the colon may occur There is distention of the bowel above the intussusception due to obstruction caused by strangulation and swelling of the intussusceptum. The sausage-like mass is easily palpable in the colon and may extend throughout its entire length. Multiple intussusceptions are sometimes seen.

Adhesions and Bands

Obstruction of the colon may occur as a result of congenital or acquired adhesions or bands extending over the colon, or between the colon and some other abdominal viscus or the peritoneal wall. Postoperative adhesions between the small and large intestine are commonly seen, but if obstruction is produced by them it is in the small bowel. Obstruction of the pelvic colon as a result of pelvic inflammatory disease or appendiceal abscess occasionally occurs, and it is usually simple to trace the distended bowel distally to the point of obstruction. The hepatic and splenic flexures and the sigmoid are more apt to be obstructed than the straighter portions of the colon

Hernias

Movable portions of the colon may make their way into an external hernia, and in sliding hernia a part of the bowel which is normally considered to be fixed may reach the sac by taking its peritoneal attachments with it. The colon may also leave the abdominal cavity through an opening in the diaphragm and may rarely be involved in internal hernias. Exploration of the inguinal and femoral rings of the diaphragm, and of the natural openings of the abdominal cavity will reveal fixation of bowel at the point where hernia has occurred.

Foreign Bodies

The usual locations for foreign bodies in the colon are the rectum and sigmoid regions, not only because these portions of the bowel by their configuration and relations, are more likely to obstruct the passage of an object, but also because foreign bodies are not uncommonly introduced through the anus Since most of these foreign bodies can be located by examination through the rectum their removal should be attempted by that route Only if this is unsuccessful should laparotomy be performed.

Since the objects are usually firmer than the normal bowel content, they can be palpated easily through the intestinal wall.

Inflammation of the Appendices Epiploica

Inflammation of one or more of these fat tabs on the colon may occur the symptoms in some cases being as severe as those of acute appendicitis. The appearance of an acutely inflamed appendix epiploica is similar to an acutely inflamed appendix, and, except that it is short, it is easily mistaken for the appendix. There is the usual peritoneal reaction of any acute inflammatory disease, and fibrinous adhesions may form between the inflamed organ and adjacent bowel.

Megacolon or Hirschprung's Disease

This is a comparatively rare disease, usually found in children but occasionally seen in adults, in which part or all of the colon is enormously enlarged so that it virtually fills the abdominal cavity The wall of the bowel is thickened, because of hypertrophy of the muscular coat, and the bowel is distended and filled with fecal matter In some cases the sigmoid and descending colon are enormously dilated and the rest of the bowel is normal, and in other cases the dilatation is confined to the ascending portion.

Regional Enteritis

This disease which has been described in the consideration of the small intestine (page 383) commonly involves the cecum and may affect other parts of the colon. It is characterized by thickening of the wall of the bowel, with narrowing of the lumen and obstruction and a tendency to sinus and fistula formation. When an area of the disease is found in the cecum, other parts of the colon and small intestine should be carefully examined because of the tendency of the disease to involve multiple segments of the intestine.

Tuberculosis

The hyperplastic form of tuberculosis, now not often seen, usually involves the cecum and produces an irregular enlargement and fixation of the cecum with symptoms of bowel obstruction. The lesion has a tendency to rupture and produce fistulous tracts and abscesses.

Actinomycosis

This disease is not uncommonly primary in the cecum but may by direct extension affect any part of the abdominal cavity There is an early tendency to perforation abscess formation and the production of sinuses and fistulas, and sulphur granules are seen in the pus.

to the small intestine. When the abdomen is opened, the distended loop has a tendency to protrude from the wound. If it does not do so the large, tense bowel is easily located by the examining hand.

Intussusception

The usual location for intussusception is the ileocecal region, and this has already been discussed under the small intestine (page 381) but intussusception of any part of the colon may occur There is distention of the bowel above the intussusception due to obstruction caused by strangulation and swelling of the intussusceptum. The sausage-like mass is easily palpable in the colon and may extend throughout its entire length. Multiple intussusceptions are sometimes seen.

Adhesions and Bands

Obstruction of the colon may occur as a result of congenital or acquired adhesions or bands extending over the colon, or between the colon and some other abdominal viscus or the peritoneal wall. Postoperative adhesions between the small and large intestine are commonly seen, but if obstruction is produced by them it is in the small bowel. Obstruction of the pelvic colon as a result of pelvic inflammatory disease or appendiceal abscess occasionally occurs, and it is usually simple to trace the distended bowel distally to the point of obstruction. The hepatic and splenic flexures and the sigmoid are more apt to be obstructed than the straighter portions of the colon.

Hernias

Movable portions of the colon may make their way into an external hernia, and in sliding hernia a part of the bowel which is normally considered to be fixed may reach the sac by taking its peritoneal attachments with it. The colon may also leave the abdominal cavity through an opening in the diaphragm and may rarely be involved in internal hernias. Exploration of the inguinal and femoral rings, of the diaphragm, and of the natural openings of the abdominal cavity will reveal fixation of bowel at the point where hernia has occurred.

Foreign Bodies

The usual locations for foreign bodies in the colon are the rectum and sigmoid regions, not only because these portions of the bowel by their configuration and relations, are more likely to obstruct the passage of an object, but also because foreign bodies are not uncommonly introduced through the anus. Since most of these foreign bodies can be located by examination through the rectum, their removal should be attempted by that route Only if this is unsuccessful should laparotomy be performed.

Since the objects are usually firmer than the normal bowel content they can be palpated easily through the intestinal wall.

Inflammation of the Appendices Epiploica

Inflammation of one or more of these fat tabs on the colon may occur the symptoms in some cases being as severe as those of acute appendicitis The appearance of an acutely inflamed appendix epiploica is similar to an acutely inflamed appendix, and, except that it is short, it is easily mistaken for the appendix. There is the usual peritoneal reaction of any acute inflammatory disease and fibrinous adhesions may form between the inflamed organ and adjacent bowel.

Megacolon or Hirschprung s Disease

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Mesenteric Thrombosis and Embolism

highly fatal disease produces dilated, thickened intestinal walls, g in color from purplish to almost black, with pinkish or bloody ieal exudate. Perforation of the involved bowel commonly occurs patient survives for any length of time.

Congenital Anomalies

position of the colon resulting usually from arrested rotation, is mally seen, with the cecum remaining on the left side of the body up on the right side, or the colon may have a persistent mesentery newborn, stricture or atresia of the colon may be encountered, and ete transposition of the viscera may occur the latter however pro- no symptoms.

Wounds or Perforations

mds involving the colon are usually the result of a gunshot or stab ay be single or multiple but crushing injuries or blows may also extensive tears of the colon. The peritoneal cavity becomes con- ted with fecal matter which soon leads to generalized peritonitis, aring of the colic vessels often results in gangrene of the bowel.

Diverticula

pouchings of the wall of the colon are common and may be dis- d throughout the entire large bowel, but they are more frequently n the descending colon and sigmoid. Most diverticula cause no oms, but occasionally inflammation may take place in one of them, ing symptoms and sequelae similar to those of acute appendicitis, ated on the left side. The changes may vary from acute inflamma the diverticulum to gangrene or perforation with localized peri abscess formation and occasionally fistula, connecting to another f bowel to the urinary bladder or to the abdominal wall. Narrow- the bowel as a result of the inflammation may occur during the stage from spasm, and with the formation of scar tissue the nar g may be permanent.

Chronic Ulcerative Colitis

entire colon may be thickened, or an area of dilated, thinned-out, cted bowel may be located proximal to a narrowed portion. Areas te inflammation may be seen, with flecks of fibrin adherent to the e, and the mesentery may be edematous and bulky The shallow al ulcers characteristic of the disease are usually not palpable h the bowel wall but an ulcer may perforate and be surrounded by ons or a localized abscess.

Benign Tumors of the Colon

The most common benign tumor of the colon is the adenoma, which forms a globular mass in the bowel easily mistaken for fecal matter when it is felt through the wall. These tumors are frequently pedunculated and vary in size from a pea to a lemon. Usually the only symptom produced by them is hemorrhage, but the larger size may cause bowel obstruction. Another type of benign tumor is the papilloma, a soft fungus-like tumor which may cover an area of the bowel several centimeters in diameter. Lipomata, often pedunculated, are not uncommon. Mucosal polyps, pedunculated growths of the mucous membrane, are occasionally seen and more rarely the condition known as multiple polyposis may be encountered. In this condition a portion or all of the colon and rectum may be almost lined with small tumors. Not infrequently one or more benign tumors of the colon may undergo malignant changes.

Carcinoma of the Colon

The large bowel is a very common site for carcinoma, and even two or more tumors present at the same time are occasionally seen. The type of the carcinoma has a tendency to vary somewhat with its location. In the ascending colon, a large, irregular hard mass is often encountered, with a tumor the size of an orange producing little or no evidence of obstruction of the fecal stream. This is true also to a large extent with tumors of the transverse colon but in the descending colon not only because the fecal matter has become less fluid in consistency but because of an actual change in the character of the carcinoma, obstruction is common. Carcinoma in this region tends to encircle the bowel and cause constriction of the lumen, so that with a tumor smaller than a golf ball there may be complete bowel obstruction. Since a very common site for carcinoma is at what surgeons call the rectosigmoid junction, where the peritoneum is reflected off the bowel, this region particularly must be very carefully palpated. Invasive extension of a tumor produces adhesions between the bowel and neighboring organs, but sometimes the ulceration so commonly present in carcinoma may extend through the wall of the bowel and cause similar adhesions but of an inflammatory nature. Thus the mere presence of adhesions does not necessarily mean that the growth cannot be resected with a reasonable chance of cure. Perforation of the bowel by carcinoma most commonly takes place in the cecum, and here an abscess may form that may be mistaken for an abscess arising from an inflamed appendix. Carcinoma of the transverse colon may occasionally extend to the stomach, and, after destroying the wall of the stomach, produce a gastrocolic fistula, although this particular lesion is more commonly seen when the carcinoma originates in the stomach. Metastasis from carcinoma of the colon takes place to the aortic glands, and this

region and the liver should always be very carefully palpated before a final decision is made on the surgical treatment.

TREATMENT

Volvulus

A lower midline incision is made and it will be found that in many cases, particularly when operation is performed early, simple untwisting of the involved bowel is sufficient to restore the blood supply and relieve the obstruction. In other cases, peritoneal bands or adhesions are present which predisposed to the volvulus and the cutting of these will release the bowel, but not infrequently and especially when the cecum is involved, it may be impossible to relieve the torsion. If the bowel cannot be freed or if after being freed it is not considered to be viable because of the absence of pulsation in the vessels and the failure of normal color to return after the loop has been surrounded by warm moist packs for about five minutes, it is necessary to remove the involved intestine from the peritoneal cavity. The two limbs of bowel, each with an adjacent segment of normal bowel, are brought out at one end of the wound, and the wound is closed around them without placing any sutures in the bowel itself. The wound is protected by vaseline gauze, and an enterostomy is made in the afferent loop, using a large-size catheter. The gangrenous bowel beyond the catheter may be clamped and cut off immediately and the clamps left on, or it may be cut off several days later when the wound is partly healed. Primary resection and anastomosis is a dangerous procedure in cases such as these and should be avoided.

Intussusception

An attempt should be made to reduce the intussusception by pressure upward from below on the invaginated portion. Pulling on the bowel is dangerous. If pressure alone is not sufficient the constricting neck may be cut with scissors at the antimesenteric border and the opening thus made closed after reduction has been accomplished. If the intussusception is reduced and the bowel is viable, no other treatment is necessary except in recurring intussusception. In these cases, an attempt should be made to fix the movable portion of the bowel, at the point where the intussusception started, to the posterior abdominal wall. This may be done by turning up a flap of peritoneum and suturing it to the mesentery. If reduction cannot be accomplished, or the loop of bowel is not viable, it should be exteriorized by the method described under volvulus. Occasionally when the patient is in very poor condition, the irreducible intussusception may be treated by ileostomy only in the hope that spontaneous reduction will occur.

Adhesions and Bands

Starting at the collapsed distal portion the intestine should be followed upward to the point of obstruction. If one is fortunate, a single band will be located which when cut will relieve the obstruction, but in most instances it is necessary to separate multiple adhesions. When these are present in the pelvis not only must the colon be guarded but the danger of opening the bladder must be kept in mind, and the position of the ureter should be visualized. The colon is very thin walled and, particularly when distended tears very easily and dissection of this type must be very painstakingly done. If the colon in spite of the greatest care should be accidentally torn or cut the opening should be closed by two inverting layers of sutures, the second or both of which may be of silk. If the wounding of the colon occurs before much of the dissection has been completed, and there has been considerable contamination, it may be wiser to perform a colostomy or cecostomy and reserve the separation of the adhesions for another operation.

Hernias

The treatment of hernias of the external variety is discussed in the chapter on The Abdominal Wall, and the treatment of internal hernias is similar to that described under the small intestine. In general however an end-to-end anastomosis of the colon after resection of a non-viable segment is rarely indicated. It is much better to exteriorize the colon and re-establish the intestinal continuity later

Foreign Bodies

Foreign bodies in the large bowel which cannot be removed through the anus must be taken out through an incision in the intestinal wall. It is better to make a longitudinal incision and after the foreign object has been removed, close the incision at right angles to the bowel by at least two layers of sutures. Occasionally the foreign body may have ulcerated through the bowel into the peritoneal cavity with the formation of an abscess. In these cases, removal of the object and drainage of the abscess is about all that should be attempted.

Inflammation of Appendix Epiploica

The inflamed appendix is clamped, tied off, and removed. If an abscess has formed, it may be impossible to find the appendix, and drainage of the region should be instituted.

Megacolon or Hirschprung's Disease

If this condition is encountered during an operation for some other disease, no more radical surgery than a cecostomy to relieve the chronic

obstruction is justifiable. Medical treatment should be given a thorough trial before surgery is indicated but if the treatment proves to be ineffective, a left lumbar sympathetic ganglionectomy may be done. This gives good results in some cases, and unless a right sympathetic ganglionectomy is also performed, it does not cause sterility In general operations on the sympathetic system should be deferred in children until the age of five at least. If sympathetic ganglionectomy is not sufficient, it may be necessary to resect the entire dilated colon but if the dilatation is limited to the right colon the ileum may be anastomosed to the transverse colon and a right colectomy only performed.

Regional Enteritis

For regional enteritis affecting the cecum and terminal ileum, the common location, an ileocolostomy between the ileum and transverse colon is usually done, cutting off the ileum above the diseased portion and anastomosing the end of it to the side of the colon. When the colon is very extensively involved and the descending portion is affected, it may be necessary to anastomose the ileum to the sigmoid below the lesion.

Tuberculosis

Tuberculosis of the cecum of the hyperplastic variety if there is no evidence of tuberculosis elsewhere in the abdominal cavity should be treated by ileocolostomy and resection of the cecum. The ileocolostomy may be done as a preliminary measure, and the resection performed only when the patient's condition permits, but if possible it is better to do the entire operation in one stage.

Actinomycosis

The surgical treatment of this disease consists merely in draining abscesses and relieving obstruction when the latter occurs. If possible, the obstruction should be relieved by releasing the adhesions or bands which cause it, but occasionally a short-circuiting operation may be necessary

Mesenteric Thrombosis and Embolism

If it is possible to exteriorize the involved segment of bowel, this should be done or the segment of bowel may be removed and the normal colon above and below the involved area brought out as permanent colostomies. At a later operation, if the patient survives, it may be possible to anastomose the ileum to the lower segment.

Congenital Anomalies

Surgery is indicated in these conditions only to relieve obstruction and may vary from a short-circuiting operation to a resection with end to-end

anastomosis, in single or multiple stages. Atresia of the colon should be treated by colostomy or ileostomy, depending on how much large bowel is present.

Diverticula

Since most cases of diverticulitis occur in the descending colon or sigmoid, a left transverse or paramedian incision gives the most convenient approach. If the inflammation is found to be in an early stage and the diverticulum is accessible, it may be removed simply by clamping and ligating its pedicle and turning in the stump by means of a serosal stitch of catgut. Many cases are not seen until perforation of the diverticulum has occurred, unless an opening in the bowel is easily located and readily accessible, nothing more than drainage of the abscess can be done. Acute or chronic obstruction of the bowel due to inflammation in and around diverticula should be treated by colostomy above the point of obstruction. The colostomy should not be closed until one is reasonably sure that the inflammatory process has subsided and no stricture is present.

If a fistula is present it is a good rule to make a colostomy first before any attempt is made to close the fistula.

Chronic Ulcerative Colitis

In most cases this condition can be satisfactorily treated by medical methods, but occasionally surgery is necessary Acute perforation of the bowel requires closure, and abscess formation requires drainage. Such complications as gastrocolic fistula, bowel obstruction, and carcinoma occurring in long standing disease, and hemorrhage or toxemia in the acute fulminating type, may call for surgical intervention.

Ileostomy is the most useful operation when obstructive or toxic symptoms are to be relieved, and may be used as a preliminary measure before colectomy When the ileostomy is to be more or less permanent, the ileum should be cut in two the distal end closed by two rows of inverting sutures, and the proximal end brought out. The peritoneum may be fastened to the ileum by a few interrupted sutures, and the wound closed around the protruding bowel in the usual way The bowel should project well beyond the skin for easier care and control. If the time comes to close the ileostomy the bowel is dissected away from the abdominal wall, the end is closed, and a lateral anastomosis is made to re-establish intestinal continuity

Benign Tumors

Local excision of benign tumors of the colon should be practiced if possible. An incision may be made in the colon the tumor and its base removed, and the opening in the colon closed by two layers of sutures. If the base of the tumor is so extensive as to necessitate the removal of a

segment of the colon this should be done and an end to-end anastomosis performed. Multiple polyposis, if it is the cause of severe symptoms, re quires very extensive surgical measures. If the entire colon and rectum are involved, it is necessary to make an ileostomy and remove the entire colon in stages. If the sigmoid is free of the growths the ileum may be anastomosed to the sigmoid and the portion of the colon above resected, or more often the rectum may be saved and the ileum anastomosed to it. Even though polyps are present in the rectum they may be destroyed by fulguration through a proctoscope.

Carcinoma of the Colon

General Considerations The nature of the surgery to be done for car cinoma of the colon depends on several factors. A lesion, particularly of the left colon may produce so much obstruction that the colon becomes enormously dilated, and it will be obvious that anything more than relief of the distention is out of the question, and that the tumor if it is to be removed, must be taken care of at a subsequent operation. If evidence of metastasis is found, either in distant lymph glands or in the liver, any thing more than a palliative operation to relieve the present or threatened obstruction is rarely indicated. If the tumor is so fixed by extension of the growth to neighboring structures that it cannot be moved about, it is useless to attempt to remove it. If on the other hand, extension has occurred to an organ such as the uterus, which can be removed at the same time as the carcinoma of the bowel, there is still a chance to cure the patient. If peritoneal implants from the tumor are present, and often this will be evidenced by the presence of ascites, the patient will many times not sur vive even the most minor surgical procedure. If perforation of the bowel has occurred with adhesions of an inflammatory nature, or if an abscess is present from the same cause, attention must be primarily directed to the treatment of a perforated lesion of the bowel. A perforated carcinomatous ulcer will rarely hold sutures, but occasionally drainage of the abscess may relieve the inflammation and make possible a later direct attack on the carcinoma, although it is true that not much can be expected in such a case.

Carcinoma of the Cecum, Ascending Colon, or Hepatic Flexure When a malignant tumor is located in any of these regions, the operative procedure is the same The ileum is cut off about 10 to 20 cm. above the cecum and the proximal end is anastomosed to the side of the transverse colon somewhat to the right of the midline. If there is much distention of the cecum or if the patient is not considered to be a good risk because of his age or general condition after the anastomosis is made the distal end of the ileum is closed by the Parker Kerr basting stitch method and dropped back into the abdomen. The second stage of the operation, the removal of the stump of the ileum, the ascending colon the hepatic

flexure and a portion of the transverse colon with closure of the distal stump of the transverse colon is performed about two weeks later If the operation is to be done in one stage it is of course not necessary to suture the distal stump of the ileum it is merely kept closed by a clamp until the operation is completed.

Carcinoma of the Transverse Colon Resection of the involved portion of the bowel followed by end to-end anastomosis is here the procedure of choice. If the patient s condition or the large size of the tumor or the extensive dissection necessary to free it, makes it seem advisable, no anastomosis is made, but clamps are applied above and below the tumor the involved segment is removed, and the clamps and ends of the colon are brought out through the abdominal wall as a double-barreled colostomy The surfaces of the two limbs of the bowel are sutured together so that when the colostomy is opened a clamp may be inserted to break down the septum (modified Mikulicz method) The proximal loop of bowel is left obstructed by the clamp for about seventy-two hours, or until adhesions have taken place between the peritoneum and bowel, and there is no danger of fecal matter getting back into the abdominal cavity (Rankin s obstructive resection) The clamp on the distal loop is left on until it loosens and falls off by itself usually at the end of five or six days. If the ascending colon is dilated due to obstruction in the transverse colon a cecostomy may be indicated as a preliminary measure and certainly an anastomosis should not be attempted when the colon is excessively distended. An appendicostomy may be used instead of cecostomy if the lumen of the appendix is large enough to admit a fair sized catheter In rare instances it may be found that, in order to remove the carcinoma, so much of the transverse colon must be removed that the two ends can not be brought together In such a case the ileum may be cut off above the cecum and anastomosed to the side of the distal segment of the colon. The distal stump of the ileum and the stump of the distal part of the colon are closed. The proximal segment of the colon is brought out as a colostomy near the umbilicus and will drain mucus permanently but this can be avoided only by removing it or by interposing a length of ileum between the two segments of colon.

Carcinoma of the Splenic Flexure and Descending Colon Resection and end to-end anastomosis preceded or accompanied by cecostomy is the procedure of choice. A portion of the left side of the transverse colon the splenic flexure and a portion of the descending colon are usually included, and here also although this is unusual if the end of the transverse colon cannot be approximated to the stump of the descending colon the ileum may be cut off above the cecum, the distal stump closed, and the ileum anastomosed to the descending colon. The proximal stump of colon is then brought out as a colostomy near the umbilicus, where it will permanently drain mucus.

Carcinoma of the Descending Colon Because of the frequency with which obstruction occurs when a tumor is present in this part of the bowel, an operation to remove the growth should nearly always be preceded by a cecostomy or appendicostomy At the end of a week or so, when the obstruction is relieved, the descending colon or sigmoid should be resected and preferably an end to-end anastomosis performed. If the growth is extensive or the resistance of the patient low it is better to do an obstructive resection.

Carcinoma of the Sigmoid Colon Resection and end-to-end anastomosis is the ideal procedure and should be preceded or accompanied by cecostomy If the two ends of bowel cannot be brought together the distal stump may be closed and dropped back into the abdomen and the proximal stump brought out as a permanent colostomy When the growth is high enough in the sigmoid so that it can be brought out on the abdominal wall the modification of the Mikulicz procedure known as the obstructive resection may be done.

Carcinoma of the Rectosigmoid and Rectum A tumor in this region should be removed by a combination of abdominal and perineal approach known as abdominoperineal resection. In some cases a rectosigmoid tumor can be mobilized enough to permit resection and end-to-end anastomosis.

The basic method, developed by Miles,[1] is a one-stage procedure in which the sigmoid is cut in two above the growth, and the proximal stump is brought out as a single-barreled colostomy in the inguinal region. The distal portion of the sigmoid and the rectum are freed down to the sacrococcygeal articulation, placed in the pelvis, the peritoneal floor of the pelvis is re-established, and the mobilized bowel is removed by the perineal route.

In the attempt to lessen the risk of this extensive operation, there have been a number of modifications of the procedure in which it is done in two or more stages. The essential differences in these modifications are the type of colostomy made the way the intra abdominal segment below the colostomy is dealt with, and the order of the perineal and intra abdominal procedures. Some of these modifications of the Miles procedure are as follows

Jones Method This is a two-stage operation in the first or abdominal phase of which the abdomen is opened through a left paramedian incision. The sigmoid and rectum are freed down to the levatores ani, pushed down into the pelvis and covered with peritoneal flaps the bowel still carrying its blood supply from the sigmoid arch. A higher loop of sigmoid is brought into the incision as a double-barreled colostomy In the second or perineal phase of the operation, the rectum and sigmoid are freed up

1 Miles W E "The Radical Abdomino-Perineal Operation for Cancer of the Rectum of the Pelvic Colon, *Brit Med. Jour* 2 941, 1910.

to the peritoneal floor where the bowel is divided between clamps. The lower segment is removed and the upper stump is closed by sutures.

Turner Rankin Method In the first stage the abdomen is opened through a midline incision, the sigmoid is cut between clamps the distal stump is closed and dropped back into the abdominal cavity and the upper stump is brought out as a left inguinal colostomy The second stage of the operation is begun by the perineal route the rectum is freed up to the peritoneum and pushed up into the hollow of the sacrum, and the posterior wound is closed. The midline abdominal wound of the previous operation is reopened, the bowel is mobilized starting with the stump which has been dropped back into the abdomen the peritoneal floor of the pelvis is incised, and the rectum is removed.

Lahey's Method This is also a two-stage procedure in the first or abdominal phase of which the abdomen is entered through a left rectus incision, the sigmoid is divided, the proximal stump is brought out through the incision as a single-barreled colostomy and the distal stump is brought out as a colostomy through a short incision in the lower midline. The lower segment is irrigated daily through the colostomy In the second stage of the operation, the distal stump is freed from the skin, the sigmoid and rectum are mobilized down to the sacrococcygeal articulation, the bowel is placed in the hollow of the sacrum, and the peritoneum is closed above it. The patient is then turned over and the bowel is removed by the perineal route.

Lockhart Mummery Method This is a one-stage operation ordinarily utilized only when the tumor is located low in the rectum but it probably has a lower mortality than the more radical procedures. A loop colostomy is first performed, and the perineal part of the operation may be done immediately or postponed until the patient's condition improves. The colostomy is made in the pelvic colon and at the same time the abdomen is explored for evidence of metastasis. By the perineal route the rectum is now freed up to the peritoneum, the peritoneum is incised, the superior hemorrhoidal vessels are divided, and the bowel is pulled down to a point well above the tumor The peritoneum is closed around the sigmoid above the point of proposed division, clamps are applied, the bowel is cut off and the stump is sutured.

Operations Designed to Eliminate Colostomy and Preserve the Rectal Sphincters Combined abdominoperineal operations which preserve the rectal sphincters have been devised by Babcock, Bacon and others and may be used in growths situated not higher than the midsigmoid. In the abdominal phase of the operation the sigmoid and rectum are mobilized down to the sacrococcygeal articulation and in the perineal phase which is performed immediately the bowel is sectioned just above the rectal sphincters and the mobilized sigmoid is pulled down through the anus.

All of the methods outlined accomplish the purpose and each has its ad

vocates. At the present time a greater attempt is being made to preserve the rectal sphincters and dispense with colostomy. In the past my preference has been an inguinal colostomy and a one-stage resection, using the Miles principle. If two stages were necessary I found the Lahey method most satisfactory, but Bacon's procedure can undoubtedly be used to advantage in many cases.

TECHNIQUE

Cecostomy

This is a useful and simply performed procedure that will *relieve obstructive symptoms* in any part of the colon except the cecum. If the

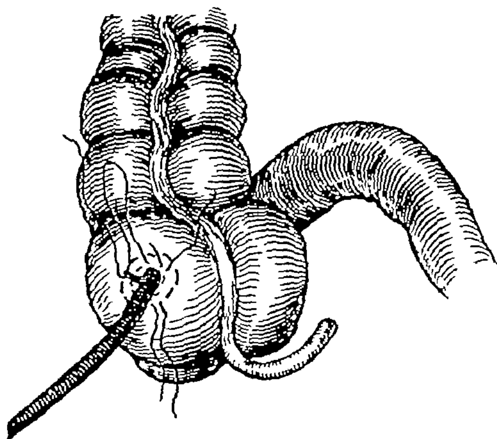


FIG. 140 *Cecostomy.* A small opening has been made in the cecum and a tube has been inserted. It is held in place by a pursestring suture, a bite being taken *in the wall of the tube. After* the first pursestring suture has been tied, another is inserted and tightened as the tube is pushed inward, thus inverting the first pursestring.

cecum itself is involved by a tumor, an ileostomy may be performed instead, using one of the techniques previously described. The opening *into the cecum made by the cecostomy closes soon* after removal of the *catheter unless the distal bowel is obstructed.* A McBurney incision is

made in the right lower quadrant the cecum is brought up into the wound, packed off and held while a pursestring suture is inserted on the presenting surface (Figure 140) A stab wound is made in the center of the pursestring a catheter with an extra eye cut in it is introduced 3 or 4 cm., the needle is passed through the side wall of the catheter and the pursestring suture is tied holding the catheter in place Another concentric pursestring suture is inserted and, as it is tightened, the catheter is pushed inward, inverting the first suture A third pursestring may now be put in and the procedure repeated. If preferred, a Pezzer catheter may be used and the same method followed. The packs are removed and the wound is closed around the catheter by the usual method If a right rectus incision has been used it is usually better to bring the catheter out through a stab wound to the lateral side of the incision.

Colostomy

General Considerations There are two kinds of colostomy the terminal or end type and the loop type. In a terminal colostomy the bowel is cut in two and when the proximal end is brought out through the abdominal wall and the distal end is closed and dropped back into the abdomen or removed, it is said to be a single-barreled colostomy When both the proximal and distal stumps are brought out through the wound it is a double-barreled colostomy Any terminal colostomy is a permanent one but a loop colostomy may be either temporary or permanent. In a temporary colostomy, the abdominal wall is not sutured together under the loop and when a temporary colostomy is opened the incision is made on the convex surface and is only large enough to permit the passage of the bowel content. The intestine is in continuity and it is possible for the fecal stream to find its way into the lower limb of the loop If the loop is cut so deeply that the passage of the bowel content from one loop to the other is interrupted, such a temporary colostomy is converted to a permanent one. In a permanent colostomy the abdominal wall is sewed together under the loop and it is impossible for the loop to retract. Even though the bowel content can pass from one limb of the colostomy to the other it will of course remain on the abdominal wall. If after the exteriorized loop of a temporary or permanent colostomy has become fixed to the abdominal wall, the loop is cut off just above the skin, the loop colostomy is converted to a double barreled end colostomy If the loop colostomy was of the temporary type the spur between the two limbs may be removed by a crushing clamp and the colostomy will then close spontaneously

Temporary Loop Colostomy in the Ascending Colon When a resection and anastomosis in the transverse or left colon is to be done it may be desirable to shunt all the fecal matter temporarily to the outside by a colostomy As the technique of the operation is fundamentally the same

regardless of what part of the colon is used, colostomy in the ascending colon only will be described.

The abdomen is opened through a large McBurney incision and the cecum is pulled up into the wound. Starting just above the ileocecal valve,



FIG 141 *Temporary Loop Colostomy* A glass tube holds the bowel in place. Two silkworm sutures have been inserted to close partially the incision in the upper and lower angles. These are ready to be tied.

the ascending colon is separated from the posterior body wall after division of the peritoneum along the lateral side of the bowel. When the cecum and part of the ascending colon have been thoroughly mobilized so that they can be brought into the wound without being under tension a pair of forceps is passed under the colon and a large-caliber rubber tube is pulled through. The ends of the rubber tube are brought together over the colon and clamped by a hemostat, and the tube is used to hold the bowel while the wound is closed around the colon just snugly enough to hold it in place without obstructing the blood supply or the lumen. The hemostat is now removed from the rubber tube, one end of which is

pushed on the end of a glass tube about 15 cm. long As the rubber tube is pulled out, the glass tube is pulled under the colon to take its place. This serves to keep the bowel from retracting until healing has taken place. A silk thread passed through the glass tube and around the colon and tied loosely will help to hold the glass tube in position (Figure 141) If necessary, the colostomy may be opened at once by packing off the bowel inserting a pursestring suture, and tying a catheter in place in a stab wound, but it is better to wait at least six and preferably forty-eight hours until adhesions have taken place between the peritoneum and the bowel and then open the colostomy by making a longitudinal incision about 3 cm. long with a cautery

A colostomy of this type will usually close spontaneously in a few weeks by the gradual retraction of the bowel but if necessary it can be closed by an operation. The bowel is freed from the abdominal wall by sharp dissection, in doing which it is helpful to have a finger in the lumen of the intestine When the bowel has been mobilized, the opening is closed by two or three inverting layers of sutures put in transversely to the axis of the bowel. Before the loop is dropped back into the abdomen, it is thoroughly washed off The peritoneum and fascia are closed by the usual method and the skin may also be closed, but because of the danger of infection it is sometimes safer to leave it unsutured and pack the wound with vaseline gauze.

Permanent Loop Colostomy This operation is most commonly used as a palliative procedure for inoperable carcinoma or to provide a permanent artificial anus when the rectum is to be removed by posterior resection. In the latter case, the colostomy is made in the sigmoid colon but it is also used in some cases of ulcerative colitis and diverticulitis. In these the opening is made in the bowel above the involved portion, which usually means in the ascending colon. More commonly however since the ascending colon is apt to be involved in the disease, an ileostomy is done instead. The location of the incision will depend upon where the colon is to be opened. For a colostomy of the ascending colon, a lower right rectus incision is usually chosen. For the transverse colon, an upper right rectus incision is used. For a colostomy in the descending colon, a left rectus incision is made at the appropriate level. The loop of bowel is drawn out of the wound and, in the case of the ascending or descending colon, mobilized by cutting the peritoneum along its lateral surface until it can be held on the abdominal wall without tension. In the case of the left colon, it may be necessary to release the splenic flexure but if the colostomy is made in the sigmoid, as is usually the case the mesentery is long enough to make this maneuver unnecessary The bowel is now held up and an opening is made between the two limbs in an avascular space far enough away from the bowel not to interfere with the vascular loop which runs near the bowel. This opening is enlarged by ligating if neces-

sary a few vessels in the region, until 3 or 4 cm. of space is obtained. A hemostat is passed through this and used to grasp one end of a rubber tube, which is pulled through. The ends of the rubber tube are brought together and held with a hemostat, and the tube is used for traction while the peritoneum is sewed together in the cleared space under the loop (Figure 142) The fascia and skin are similarly united in this space, and the wound is closed snugly around the bowel, with care, however not to obstruct the lumen or the blood supply The rubber tube is now removed and the loop of bowel is covered with vaseline gauze. If necessary the colostomy may be opened immediately by inserting a pursestring suture, making a puncture wound, and passing in a catheter which is tied in place, but it is better if possible to wait for two or three days, when the colostomy may be opened by making an incision with a cautery half way through the wall of the bowel at right angles to the axis. A few days later if desired, the limbs of the bowel may be completely divided, leaving a double barreled colostomy

When a colostomy is made in the transverse colon, the procedure is essentially the same, except that here the necessary opening is made under the bowel through the transverse mesocolon and the gastrocolic ligament.

Appendicostomy

If the appendix has a patent lumen of sufficiently large caliber to admit a small to medium-size catheter and if the appendix is long enough to reach between the cecum and the skin and movable enough so that it can be brought into such a position, appendicostomy provides a simple and satisfactory method of relieving obstruction of the colon and may be used in place of cecostomy Actually because of the foregoing limitations, the operation is not often used. The abdomen is opened preferably by a McBurney incision the cecum is brought up into the wound, the appendix is located and freed, and pulled out through the wound with its mesentery intact. A few sutures are made between the parietal peritoneum and the cecum in the region of the appendix, if the cecum is not distended and thinned out. The wound is closed around the appendix by the usual method the tip of the appendix is cut off and a catheter is inserted into the cecum.

Ileocolostomy

After resection of the proximal colon, the continuity of the intestinal tract is accomplished by anastomosing the ileum to the transverse colon below the point of resection. If the resection is done in two stages, the first phase of the operation is this anastomosis, and although a side-to-side anastomosis between the colon and the ileum may be performed and the ileum not severed from the cecum until the second operation, the more common procedure is to cut the ileum off 10 or 12 cm. above the cecum

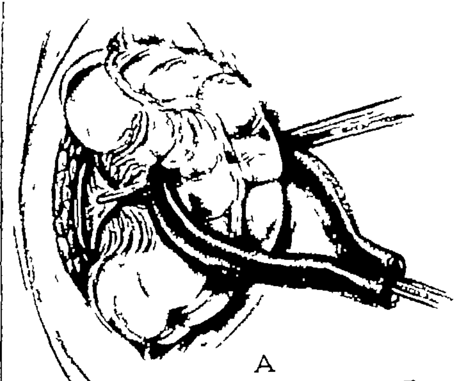




FIG. 142. *Permanent Loop Colostomy* A. The mesentery of the bowel has been divided, a rubber tube has been passed through the opening and around the bowel, and the peritoneum is being brought together under the bowel. B The suturing of the peritoneum has been completed.

and anastomose the end of the ileum to the side of the colon. About 10 or 12 cm. above the cecum, the ileum is divided between two clamps. The *distal stump of the ileum is closed by the* Parker Kerr basting-stitch technique· or if the colon is to be removed at the same sitting, the clamp is simply left on the distal stump In incising the mesentery of the ileum, care should be taken not to cut the mesentery back beyond the stump of the ileum any more than necessary to make the anastomosis. Allis forceps are now applied to the under surface of the colon about 4 cm. apart in its long axis, and a straight, narrow hemostat is put on the wall of the bowel below the Allis forceps. When it is arranged so that the entire thickness of the bowel protrudes above the clamp the clamp is closed and the protruding intestine is cut off with the cautery The field is now packed off and the clamp on the colon and that on the end of the ileum are arranged so that they are parallel and close together With fine chromic catgut on a curved intestinal needle, the adjacent surfaces of colon and ileum are brought together by a running or Parker Kerr basting stitch applied below the clamps (Figure 143A) This stitch is pulled tight and tied, and then the clamps are rotated so that the bowel surfaces on the other side of the clamps are approximated as much as possible. A similar basting stitch is put in with the suture passing over the clamps (Figure 143B) and this time the stitch cannot be pulled tight until after the completion of the suture line, when the clamps are removed. This suture is not tied until after the clamps have been taken off and the bowel has been approximated. The bowel openings are so crushed by the clamps that the clamps can be taken off and the suture line pulled tight with little danger of leakage (Figure 143C) A reinforcing serosal suture is now put in around the circumference of the anastomosis, *using* a continuous Lembert stitch, and after the completion of this row the ileum and colon are grasped between thumb and finger and the crushed portions of the bowel opened up.

For making this anastomosis and other anastomoses necessary in resection of the colon, several so-called aseptic methods of suturing have been devised. The operation just described was done by the commonly used Parker Kerr basting stitch technique, but there is no great objection *to making an anastomosis of the open type*, applying a rubber-covered clamp to the end of the ileum and a similar clamp to the colon and doing the suturing the same as in a gastrojejunostomy In surgery of the colon, the region should of course be well packed off from the rest of the bowel and whether or not an aseptic method is used is not as important as that the anastomosis be skilfully done.

Ileocolostomy may also be performed by closing the ends of the ileum and colon over small Payr clamps, using the Parker Kerr basting stitch technique and here as elsewhere when this type of stitch is put in, one should take the stitches a liberal distance from the clamps to simplify the

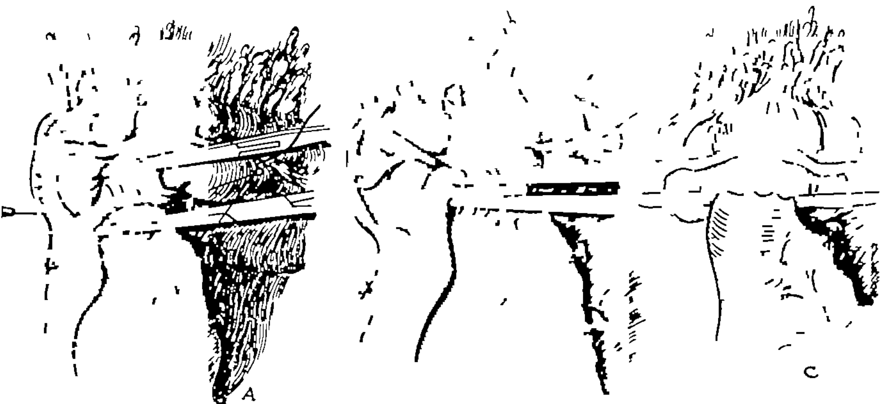


FIG. 143. *Ileocolostomy* A. The first serosal layer of sutures is being inserted. B The second serosal layer has been put in over the clamp C. The sutures have been tightened as the clamps were removed. Another layer of sutures will be inserted to reinforce further the anastomosis, and the crushed spur of the bowel will be opened by pressure between the finger and thumb.

turning in of the stump The first suture line should be reinforced by another continuous suture of fine chromic catgut. After the ends of the ileum and colon are closed, rubber-covered Doyen clamps are applied to the side of the ileum and colon a short distance away from the closed end, the region is packed off, and an open side to-side anastomosis is performed. Fine chromic catgut can be used for the two layers of suture, and if desired a third layer of sutures, either continuous or interrupted, can be inserted further to reinforce the other two suture lines.

Ileosigmoidostomy

This operation has been employed as a means of resting the colon in ulcerative colitis, although it is seldom used for this purpose at the present time It is more commonly used after subtotal colectomy for such a condition as multiple polyposis, and after a resection of the splenic flexure of the colon when the transverse colon cannot be anastomosed to the descending colon below the resected area. An incision is made in the left paramedian region. A loop of ileum is selected about 10 to 20 cm. above the cecum, the ileum is cut off and, unless the colon is to be removed, the stump of the ileum is closed over a small Payr clamp using two layers of sutures. The stump of the proximal loop is similarly closed, and after the ileum has been approximated to the sigmoid as close to the rectosigmoid junction as is conveniently possible, a lateral anastomosis is done.

Resection and End-to-End Anastomosis

The colon is freed from its peritoneal attachment so that it can be lifted up, or in the case of the transverse colon openings are made through the transverse mesocolon and gastrocolic ligament above and below the area to be resected. The wall of the bowel is freed of blood vessels for a short distance, so that two clamps can be introduced side by side at each point where the bowel is to be cut. For this purpose, small Payr clamps or straight hemostats may be used. The segment to be resected is elevated and, starting at the openings already made, the branches of the colic vessels supplying the loop are progressively clamped and ligated in a wide V until the bowel and regional glands can be removed. When an anastomosis is being performed in the lower sigmoid region, additional slack may be obtained by cutting the peritoneal attachments of the lower segment and freeing the rectum in the hollow of the sacrum. In cutting the bowel in two the region is well packed off and the cautery used. The two clamps on the healthy portions of the bowel are now approximated. An opened sponge to which a hemostat is attached is laid between them and, starting at the point away from the operator a running serosal suture is introduced uniting the adjacent surfaces below the clamps (Figure 144A) The end of this suture is left long and marked with a hemostat. When this suture reaches the edge of the bowel nearest

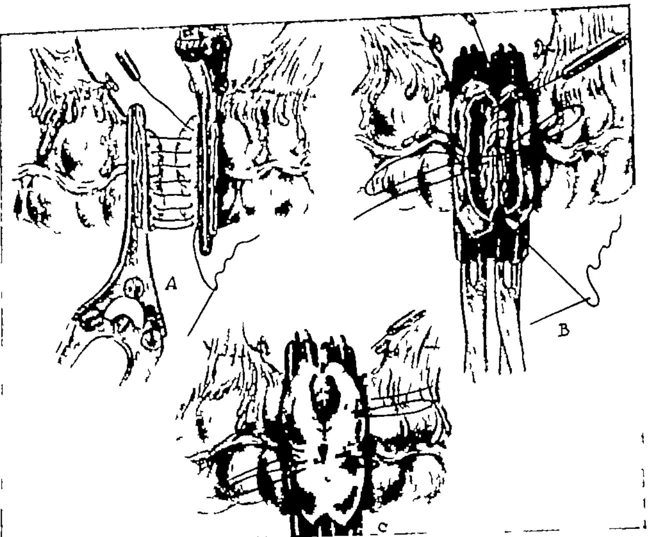


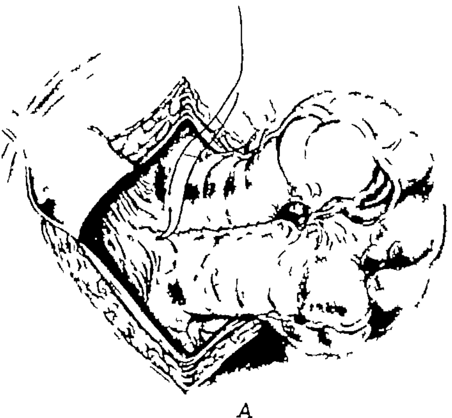
FIG. 144. *End-to-End Anastomosis of the Colon.* A. The first serosal layer of sutures. B The Payr clamps have been removed and replaced by rubber-covered clamps farther back. The crushed ends of the bowel have been opened and the second posterior layer of sutures is being inserted. These sutures pass through the entire wall of the bowel. C. The first anterior layer of sutures is being put in as a Connell stitch and the second serosal layer is also partially completed. When an anastomosis is to be made in the depth of the pelvis, sharply curved rubber-covered clamps must be used.

the operator, it is locked, laid down, and covered with a moist pack. Rubber-covered Doyen clamps are now applied to the bowel below the crushing clamps, the latter are removed, and the crushed portion of the bowel is cut off opening the lumena. The fecal matter is sponged away and, starting at the point away from the surgeon a running suture through all the layers of the bowel is inserted (Figure 144B) The end of the suture is left long and marked with a hemostat. When this suture line reaches the point nearest the operator it is locked and continued back to the starting point as a Connell suture (Figure 144C) At the opposite side of the bowel it is tied to the original end, which was left long. The Doyen clamps are now removed, the bowel is washed with saline, clean packs are applied to the region, and the original serosal suture is continued back to its starting point as a running stitch and tied to the original end. A few interrupted stitches are now used to close any openings in the mesocolon or peritoneum through which a loop of bowel might prolapse. In making this anastomosis, it is essential to remove the fat from the surface of the bowel by clipping it off with scissors, so that good serosal approximation is secured.

An end to-end anastomosis may also be made by the Parker Kerr technique, which was described under ileocolostomy (page 434)

Mikulicz Procedure

This operation is not too satisfactory for use in carcinoma of the bowel, because of inadequate removal of lymph glands and because of the danger of the carcinoma s becoming implanted into the wound. It is of limited value when it is desired to exteriorize the bowel for other conditions. Its advantage is that it makes unnecessary a secondary operation to reestablish intestinal continuity When the operation is performed in the sigmoid region, a left rectus or left paramedian incision is made. The loop of sigmoid is drawn out of the wound and mobilized as much as necessary by cutting the peritoneum along its lateral side. A puncture is made in the mesentery and, starting from this point, the mesentery is progressively clamped so that a V-shaped segment is excised corresponding to the bowel that is to pass through the abdominal wall and be exteriorized. The mesentery is not cleared at any point closer than 2.5 cm. from the bowel so that the loop will retain its blood supply While gentle traction is made on the loop the two limbs of bowel are sutured together over a distance of about 7 or 8 cm. The limbs of bowel are now rotated and a similar suture line is placed between them about 2.5 cm. away from the first with care not to include the mesenteric border between them (Figure 145A) These suture lines may be interrupted or continuous catgut is satisfactory for the suture material. A few interrupted sutures are now placed between the lateral peritoneal wall and the mesentery of the proximal limb of bowel, to prevent herniation of the small intestine through



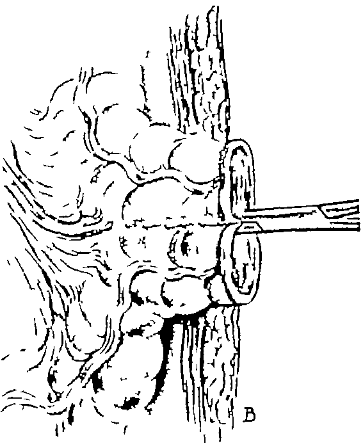


Fig. 145 *Mikulicz Procedure.* A. A loop of bowel has been mobilized, a segment of mesentery removed and the bowel drawn out of the wound. The first layer of sutures between the two limbs of bowel has been inserted and the beginning of the second layer is shown. B A clamp has been applied to crush the spur between the two limbs of bowel.

this region into the lumbar gutter The exteriorized bowel may be brought out through the left rectus incision, or a small McBurney type of incision may be made farther laterally and the bowel brought out through this. The wound is closed, care being taken not to make the closure so tight as to obstruct the lumen or interfere with the blood supply The exteriorized loop of bowel is left in place for seventy two hours or longer, and then is cut off with the cautery At the end of a week or more, the spur between the two limbs of bowel is crushed by applying a heavy straight hemostat or a special clamp (Figure 145B) inserting it with the fingers in the bowel as a guide, and gradually tightening it. The septum is ordinarily completely crushed in about two days. If at the end of this time examination shows that the spur is not cut deeply enough, the clamp is applied again. Usually this type of colostomy will close spontaneously at the end of a few weeks, but if necessary it may be closed by separating the limbs of the bowel from the skin and abdominal wall, using the finger in the lumen as a guide, and closing the opening with a Connell suture reinforced by a continuous serosal stitch. As soon as the bowel has been freed, Doyen clamps are applied to each limb to prevent fecal leakage.

Obstructive Resection

This is a modification of the Mikulicz procedure, useful when it is desired to remove a carcinoma of the bowel by that method and not leave the tumor in contact with the wound. When the operation is to be done in the transverse colon, the omentum is first removed from the region to be resected, otherwise the peritoneal attachment of the colon is cut along its lateral border The blood vessels are ligated in the mesentery and a wide V of mesentery with regional glands is incised. The bowel is doubly clamped well out on each side of the growth, and the segment is removed with the cautery The clamps and the two bowel ends are brought out through the abdominal wound, or through a McBurney incision, and held in place by being strapped to the abdominal wall with adhesive. No sutures are placed in the bowel. The clamp on the upper limb is left closed for seventy two hours if possible, but it may be opened sooner if necessary The clamp on the lower limb is left on until it falls off of its own accord usually after five or six days.

Resection of the Cecum Ascending Colon, and Hepatic Flexure

A long right paramedian incision is made, the terminal ileum is drawn up into the wound, and, at a point about 10 cm. from the ileocecal valve, a few mesenteric vessels are cut and tied and the bowel severed between clamps with the cautery The proximal stump may now be anastomosed to the transverse colon by the method described under ileocolostomy or the anastomosis may be done after the removal of the right colon. If there is a possibility that the entire operation cannot be done at one time the



FIG. 148 *Resection of the Cecum Ascending Colon, and Hepatic Flexure.* The ascending colon has been mobilized by cutting the peritoneum along the lateral surface, and the colon rolled inward exposing the ureter adherent to its under surface in this case. The mesentery of the ileum has been divided and two clamps applied Viewed from the extreme right, though deep and medially placed, the psoas muscle is brought into exaggerated view by elevated traction of the cecum and the ascending colon

first method should be used, since the operation can be concluded at the completion of the ileocolostomy The distal end of the ileum is closed by inversion and suture The colon is now drawn to the left, and the lateral peritoneum is cut upward toward the hepatic flexure so that the bowel can be rolled over medially (Figure 148) Care should be taken that the

ureter which has a tendency to adhere to the bowel, is not carried with it, and the spermatic vessels should also be guarded. At the hepatic flexure, the bowel is displaced inward and downward and the hepatocolic ligament is cut, exposing the duodenum. Thus far in the dissection, no blood vessels of importance are encountered except for an occasional one in the hepatocolic ligament. The colon is now lifted out of the abdomen, and its mesentery is clamped and cut far enough from the bowel to include lymph glands along the course of the ileocolic, right colic, and middle colic vessels. The terminal ileum with its regional glands is removed along with the colon. At the point chosen for section of the transverse colon, usually a convenient distance beyond the hepatic flexure, the bowel is cleared of fat and two small Payr clamps are applied side by side (Figure 147), and, after packing off the region, the bowel is severed with the cautery The distal stump is closed using the Parker Kerr technique, reinforcing the first row of sutures by a second and, if desired, a third layer If ileocolostomy has not already been performed, it is done at this time either the end of the ileum being connected to the side of the colon, or the end of the ileum closed and a lateral anastomosis performed. The raw surface left by removal of the colon is covered as well as possible by suturing the peritoneum over it. One or two Penrose drains are left in for a few days to take care of serum, which may collect in the lumbar gutter

Removal of Splenic Flexure and Descending Colon

The abdomen is opened by a long left paramedian incision, the small bowel is packed off and, with the use of scissors an incision is made in the peritoneum along the lateral border of the bowel. The colon is now rolled inward, and as it is loosened it is lifted out of the abdomen. The ureter has a tendency to roll inward with the bowel and should be guarded carefully as should the spermatic vessels. It will be necessary to cut the phrenicocolic ligament, and occasionally it is necessary to remove the spleen in order to mobilize the splenic flexure. The bowel being held up the left colic vessels are clamped and tied close to the root of the mesentery and thus far enough from the bowel to include the regional lymph glands. It is also desirable to clamp tie off, and remove the section of omentum attached to the part of the transverse colon to be removed. The bowel is now doubly clamped at a convenient point in the transverse colon and in the descending colon well below the lesion, severed between the clamps by the cautery and the involved segment is removed. The raw surface is peritonealized as well as possible. An attempt should now be made to bring the stump of the transverse colon down to the stump of the descending colon for an end to-end anastomosis If this can be done without tension, and it usually can an anastomosis is performed by the method already described. If it cannot be accomplished, the distal stump should

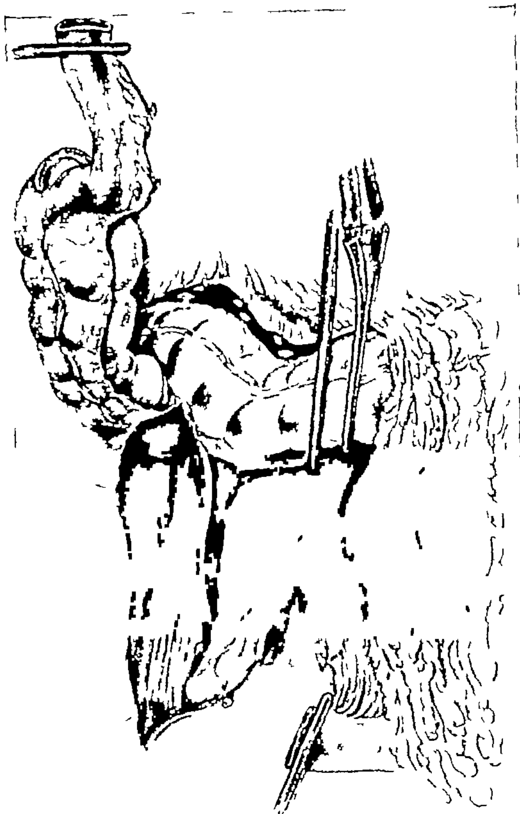


FIG. 147 *Resection of the Cecum, Ascending Colon, and Hepatic Flexure* The ascending colon has been freed and the omentum has been stripped from part of the transverse colon. The gastrocolic ligament has been partially divided, and clamps have been applied to the transverse colon preparatory to sectioning it. The lower pole of the right kidney and the ureter are shown.

ureter which has a tendency to adhere to the bowel, is not carried with it and the spermatic vessels should also be guarded. At the hepatic flexure, the bowel is displaced inward and downward and the hepatocolic ligament is cut, exposing the duodenum. Thus far in the dissection, no blood vessels of importance are encountered except for an occasional one in the hepatocolic ligament. The colon is now lifted out of the abdomen, and its mesentery is clamped and cut far enough from the bowel to include lymph glands along the course of the ileocolic, right colic, and middle colic vessels The terminal ileum with its regional glands is removed along with the colon At the point chosen for section of the transverse colon usually a convenient distance beyond the hepatic flexure, the bowel is cleared of fat and two small Payr clamps are applied side by side (Figure 147) and after packing off the region, the bowel is severed with the cautery The distal stump is closed using the Parker Kerr technique, reinforcing the first row of sutures by a second and, if desired, a third layer If ileocolostomy has not already been performed, it is done at this time either the end of the ileum being connected to the side of the colon, or the end of the ileum closed and a lateral anastomosis performed. The raw surface left by removal of the colon is covered as well as possible by suturing the peritoneum over it. One or two Penrose drains are left in for a few days to take care of serum, which may collect in the lumbar gutter

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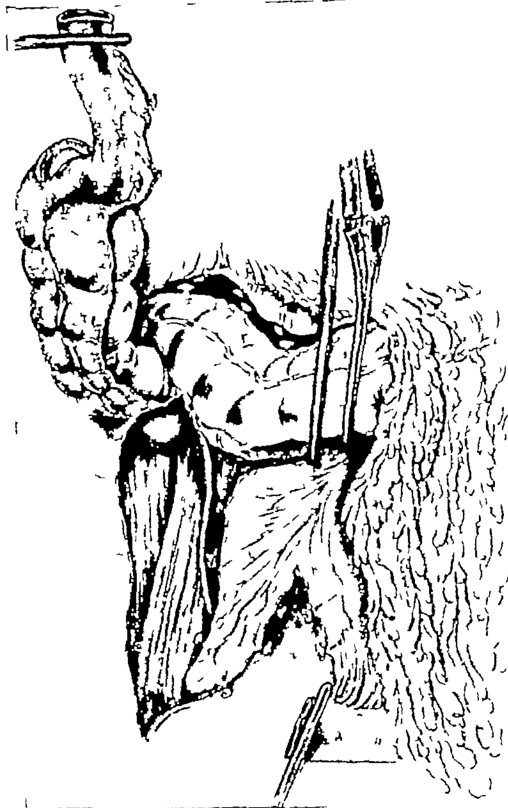


FIG 147 *Resection of the Cecum, Ascending Colon, and Hepatic Flexure* The ascending colon has been freed and the omentum has been stripped from part of the transverse colon. The gastrocolic ligament has been partially divided, and clamps have been applied to the transverse colon preparatory to sectioning it. The lower pole of the right kidney and the ureter are shown.

be closed and the upper stump brought out through a stab wound near the umbilicus as a single barreled colostomy, and an ileosigmoidostomy should be performed. Because of the tendency of lesions of the descending colon to produce severe obstruction of the bowel resection of the left colon should usually be preceded or accompanied by a cecostomy done through a McBurney incision in the right lower quadrant.

Total Colectomy

This operation which may be indicated for congenital megacolon or multiple polyposis and occasionally ulcerative colitis, is done in several stages the first of which is ileostomy When the patient's condition im-

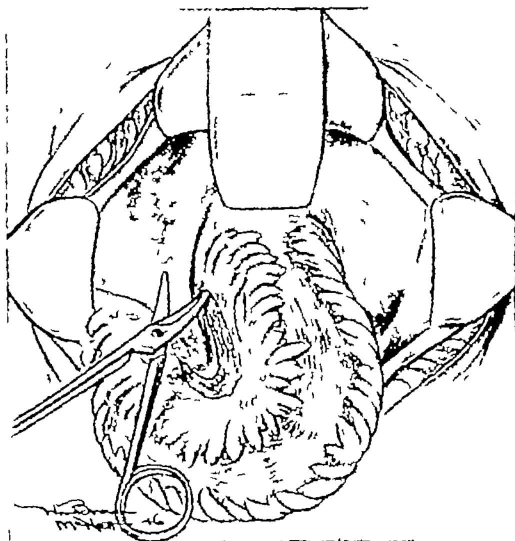


FIG. 148 *Abdominoperineal Resection.* Figures 148–51 are viewed from an anterior superior position The patient is in ... tion. In Fig 148 the peritoneum is being incised along the ... colon after it crosses the pelvic brim. The dista... ...ssing posterior to the bladder which is retracted.

proves sufficiently the entire colon down to the rect... removed, separating the omentum from the transverse c... and leaving it in place The third stage consists of rem... and the rectum by the abdominoperineal method. If the ... rectum are not to be included in the resection, an ileo... should be performed. Removal of the ascending colon and ... have already been described. In order to release the transverse c... merely necessary to clamp the vessels in the gastrocolic ligam... transverse mesocolon and cut these structures. The dissection is b... the ascending colon and continued distally along the bowel. After ... of the colon, the raw surface is peritonealized in both lumbar gutt...

Abdominoperineal Resection in One Stage

The abdomen is opened by a long left paramedian incision ... as near to the symphysis as possible. The patient is placed in ... enburg position, the small bowel is packed off and a self-... tractor of the Balfour type is inserted. The sigmoid colon is ... toward the right and the peritoneum along its lateral bor... with scissors (Figure 148) This incision is extended down ...



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Fig 149 *Abdominoperineal Resection.* The peritoneal ... anterior to the terminal portion of the sigmoid and ... lateral margin.

neal floor, where it passes in front of the rectum, and then as the sigmoid is pulled toward the left, the incision is extended along the median peritoneal leaf of the mesentery (Figure 149) At a point level with the

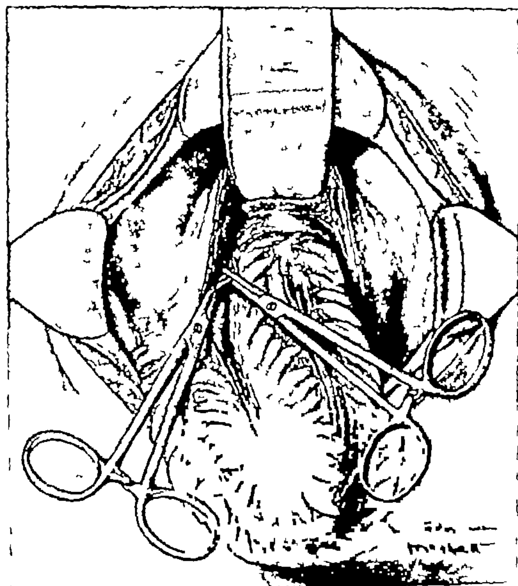


FIG. 150 *Abdominoperineal Resection* The superior hemorrhoidal vessels are clamped

promontory of the sacrum, the superior hemorrhoidal vessels are identified and cut between suture ligatures (Figure 150) Care must be taken to ligate the vessels below the sigmoid branch, as otherwise the blood supply of the sigmoid loop which is to be preserved may be endangered. The hand is now inserted through the incised peritoneum and is passed down behind the rectum into the hollow of
down as far as the sacrococcygeal articu
ureter at the brim of the pelvis should be watched for and guarded. The

anterior surface of the rectum is now freed from the bladder and down ward to the level of the seminal vesicles and prostate, or along the posterior vaginal wall in the female Lateral fascial bands coming in from the

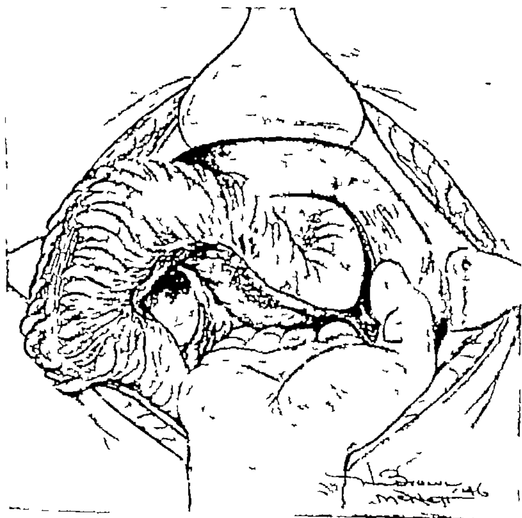


FIG 151 *Abdominoperineal Resection* Following manual dissection of the retrosigmoid soft structures, the sigmoid colon is now mobilized in the hollow of the sacrum.

sides of the pelvis with the middle hemorrhoidal arteries just on top of the levatores, are clamped and tied. One should use care in not forcing the hand too closely along the hollow of the sacrum, so as to avoid injury to the middle sacral artery A low loop of the sigmoid, which will extend easily to the outside of the abdominal wall is now selected, and it is tied twice with heavy fish line and divided between the ligatures with a cautery (Figure 152) Both of these stumps are now closed with thin rubber sheeting and this is tied in place with heavy cord. The lower segment is further mobilized by clamping and ligating its remaining mesentery and is pushed down into the hollow of the sacrum. The peritoneal

floor of the pelvis is re-established, if necessary loosening the peritoneum laterally to obtain more slack and using the bladder in the male or the uterus in the female to fill the gap A left McBurney incision is made just medial to the anterior superior spine and a hemostat is inserted and

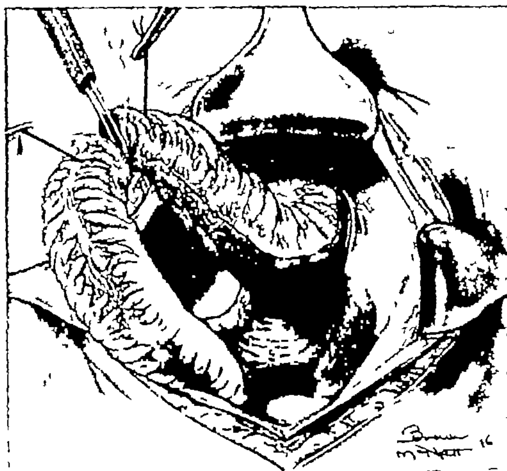


FIG. 152. *Abdominoperineal Resection.* The bowel is divided with a cautery above the level of the growth.

used to grasp the cord attached to the end of the proximal stump. The sigmoid is pulled through the incision, and it is most important that the bowel lie in its position without being under tension (Figures 153 and 154) A few peritoneal stitches may be taken to attach the mesentery of the sigmoid to the abdominal wall. The McBurney incision is now closed snugly around the bowel with care not to make the incision so tight as to obstruct the lumen. The paramedian incision is closed and the patient is turned over and placed in a reversed Trendelenburg position, with the hips elevated and the head down A pursestring suture of heavy silk is inserted in the anus to close it and a longitudinal incision is made, starting at the sacrococcygeal articulation and passing downward to encircle the

anus. The incision is deepened, the sacrococcygeal joint is identified, and if necessary the coccyx is cut off and removed. Any bleeding caused by the disarticulation can usually be controlled by pressure. The incision is held apart by retractors and deepened on each side of the rectum to the

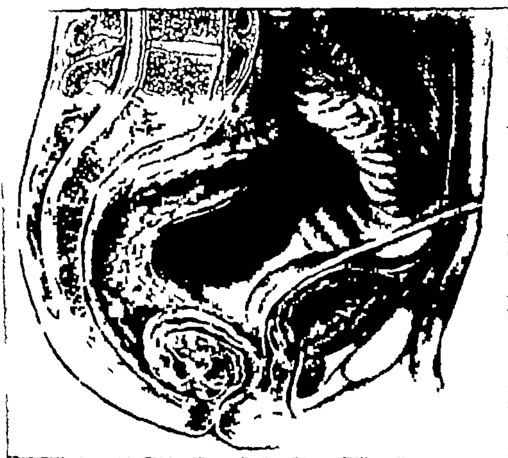


FIG. 153. *Abdominoperineal Resection.* Lateral view showing the proximal segment brought out as a single-barreled colostomy and the distal segment placed in the pelvis with the perineal floor re-established above it.

levatores. These are lifted up with the finger and cut as far away from the rectum as possible Just below the sacrum, the fascia propria is now incised, and through this opening, which is enlarged as much as necessary the bowel which had been placed in the pelvis is pulled out (Figure 155) Extreme care must be used not to make any tension on the bowel, since carcinoma so weakens the wall that it is very friable and easily torn. The upper end of the rectum having been delivered, the bowel is now separated from the vagina or prostate by careful dissection, and this is continued outward until the rectum and anus are freed A piece of rubber tissue is inserted into the posterior wound, which is packed full of loose gauze to give the pelvic floor support for about three days.

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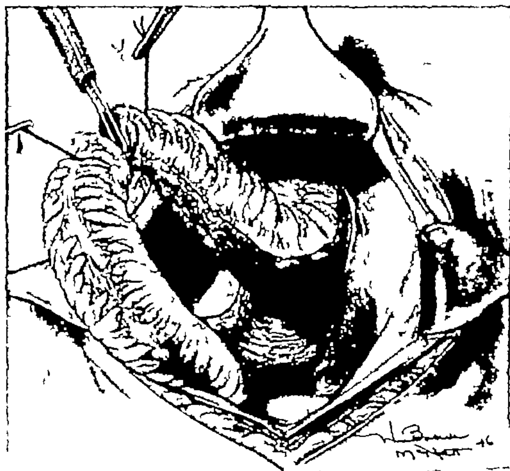


FIG. 152. *Abdominoperineal Resection.* The bowel is divided with a cautery above the level of the growth.

used to grasp the cord attached to the end of the proximal stump. The sigmoid is pulled through the incision, and it is most important that the bowel lie in its position without being under tension (Figures 153 and 154) A few peritoneal stitches may be taken to attach the mesentery of the sigmoid to the abdominal wall. The McBurney incision is now closed snugly around the bowel with care not to make the incision so tight as to obstruct the lumen. The paramedian incision is closed and the patient is turned over and placed in a reversed Trendelenburg position, with the hips elevated and the head down. A pursestring suture of heavy silk is inserted in the anus to close it and a longitudinal incision is made starting at the sacrococcygeal articulation and passing downward to encircle the

Lahey Method

In the first stage of the operation, the abdomen is opened by a left rectus incision, the sigmoid is drawn to the right and the peritoneum is cut along its lateral border A point on the sigmoid is chosen so that after division both segments will be long enough to extend through the abdominal wall, the proximal end in the region of the incision and the distal end in the suprapubic region. Just at the level proposed for section, a small opening is made in the mesosigmoid and a tape is passed through to be used for traction. The bowel is pulled to the left and the mesentery is divided at right angles to the sigmoid down to the level of the superior hemorrhoidal vessels, but not including them. A short midline incision is made in the suprapubic region and through this a long clamp is introduced and used to grasp the bowel at the point to be sectioned. Just above and beside this, a second clamp is applied and the bowel is cut between them with the cautery The first clamp is withdrawn and the distal stump is pulled through the suprapubic wound, where the skin is closed snugly about it. The clamp on the upper segment is used to pull the proximal stump out through the rectus incision and, while the bowel is held in position, the mesosigmoid is fastened by a few interrupted sutures to the lateral abdominal wall. The incision is closed around the bowel without putting any sutures in the bowel itself. The clamp is left on the lower segment for five or six days and on the upper segment for forty-eight hours, but if necessary a catheter may be sutured at once in the upper stump below the clamp At the end of a week the lower segment of bowel is irrigated regularly through the colostomy

The second stage of the operation usually performed in about two weeks is begun by separating the suprapubic segment from the abdominal wall and at the same time making a long midline incision. The stump of the bowel is closed over with rubber dam the segment is mobilized and placed in the pelvis, and the pelvic floor is re-established. The incision is closed and the patient is turned on the left side in a Sims position, where the perineal phase of the operation is performed.

The Lockhart-Mummery Method

At the first stage of this operation, a permanent left inguinal loop colostomy is made, and the second stage of the operation is performed about ten days later depending on the condition of the patient. The reversed Trendelenburg position is used, the anus is closed with a heavy purse-string suture, the coccyx is removed (Figures 156 and 157) and the incision is deepened on both sides of the rectum down to the levator muscles. These are divided (Figure 158) as far from the rectum as possible, and an incision is made through the fascia propria just below the sacrum. Through this opening the hand is inserted into the hollow of the sacrum

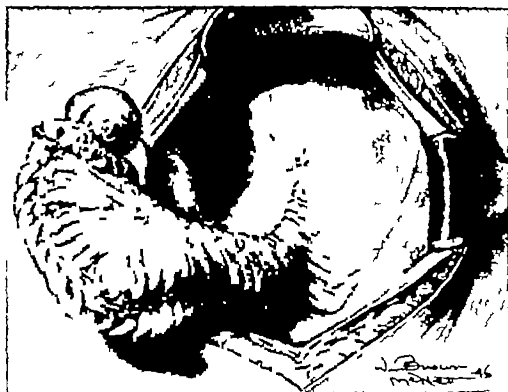


Fig. 154 *Abdominoperineal Resection.* Peritonealization has been completed in the pelvis and along the mesosigmoid. The end of the proximal limb of bowel that is to be brought out as a colostomy is covered with rubber tissue.

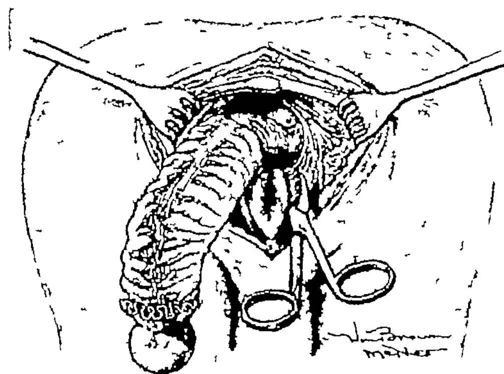


Fig 155 *Abdominoperineal Resection.* The coccyx has been removed, the levatores are being severed, and the distal loop of sigmoid that had been placed in the pelvis is drawn out of the wound.

Lahey Method

In the first stage of the operation the abdomen is opened by a left rectus incision, the sigmoid is drawn to the right, and the peritoneum is cut along its lateral border A point on the sigmoid is chosen so that after division both segments will be long enough to extend through the abdominal wall, the proximal end in the region of the incision and the distal end in the suprapubic region. Just at the level proposed for section a small opening is made in the mesosigmoid and a tape is passed through to be used for traction. The bowel is pulled to the left and the mesentery is divided at right angles to the sigmoid down to the level of the superior hemorrhoidal vessels but not including them. A short midline incision is made in the suprapubic region and through this a long clamp is introduced and used to grasp the bowel at the point to be sectioned. Just above and beside this, a second clamp is applied and the bowel is cut between them with the cautery The first clamp is withdrawn and the distal stump is pulled through the suprapubic wound, where the skin is closed snugly about it. The clamp on the upper segment is used to pull the proximal stump out through the rectus incision and, while the bowel is held in position, the mesosigmoid is fastened by a few interrupted sutures to the lateral abdominal wall The incision is closed around the bowel without putting any sutures in the bowel itself The clamp is left on the lower segment for five or six days, and on the upper segment for forty-eight hours, but if necessary a catheter may be sutured at once in the upper stump below the clamp At the end of a week the lower segment of bowel is irrigated regularly through the colostomy

The second stage of the operation, usually performed in about two weeks, is begun by separating the suprapubic segment from the abdominal wall and at the same time making a long midline incision. The stump of the bowel is closed over with rubber dam, the segment is mobilized and placed in the pelvis, and the pelvic floor is re-established. The incision is closed and the patient is turned on the left side in a Sims position, where the perineal phase of the operation is performed.

The Lockhart Mummery Method

At the first stage of this operation a permanent left inguinal loop colostomy is made and the second stage of the operation is performed about ten days later depending on the condition of the patient. The reversed Trendelenburg position is used, the anus is closed with a heavy purse string suture, the coccyx is removed (Figures 156 and 157) and the incision is deepened on both sides of the rectum down to the levator muscles. These are divided (Figure 158) as far from the rectum as possible, and an incision is made through the fascia propria just below the sacrum. Through this opening the hand is inserted into the hollow of the sacrum

Fig 156 *Posterior Resection of the Rectum (Lockhart-Mummery)* Incision.

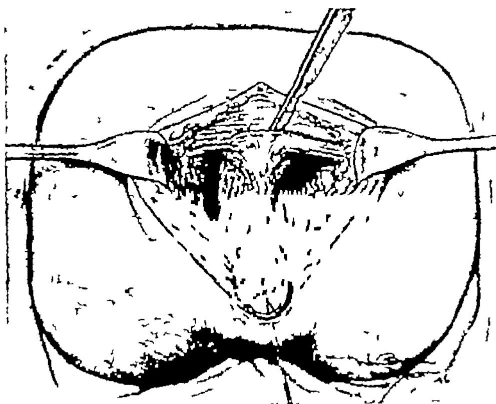


Fig 157 *Posterior Resection of the Rectum.* Removal of the coccyx.



FIG. 158 *Posterior Resection of the Rectum.* Division of the left levator

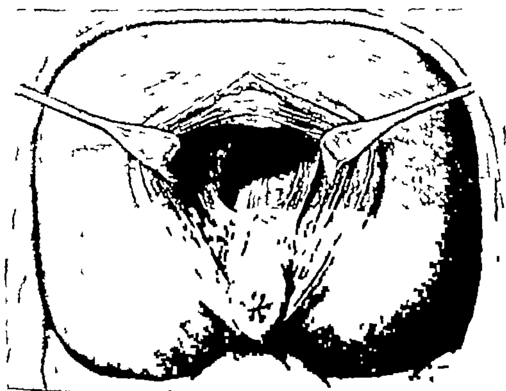


FIG. 159 *Posterior Resection of the Rectum* The rectum has been freed in the hollow of the sacrum.

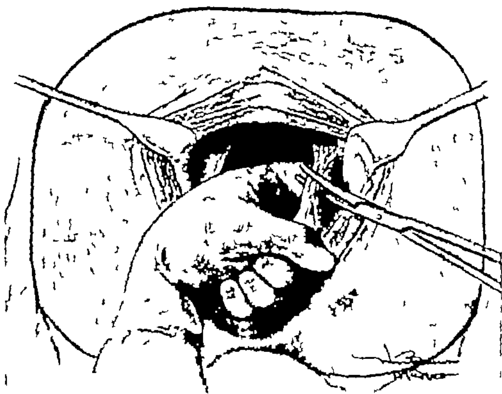


FIG. 160. *Posterior Resection of the Rectum.* Division of right triangular ligament, which contains the middle hemorrhoidal vessels.

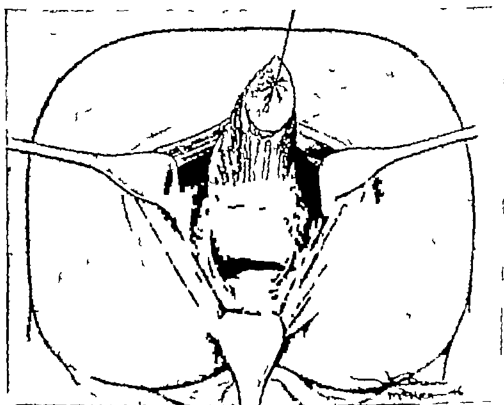


FIG. 161 *Posterior Resection of the Rectum* The peritoneum has been opened in cul-de-sac.

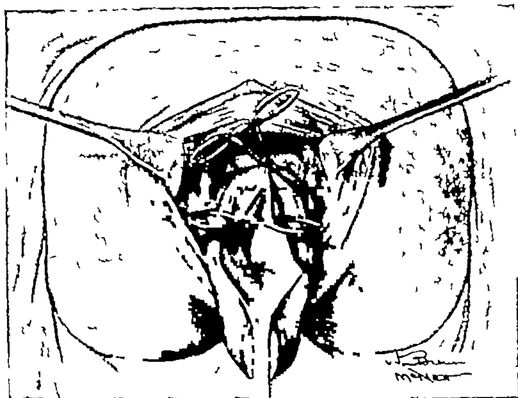


FIG. 162. *Posterior Resection of the Rectum.* The superior hemorrhoidal vessels are being clamped high on the rectum.

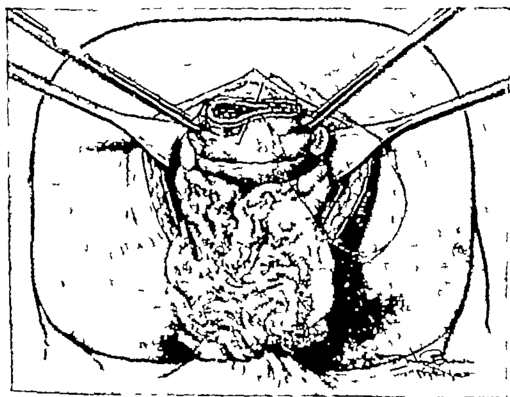


FIG. 163 *Posterior Resection of the Rectum* The peritoneum has been sutured to the stump of bowel, and the bowel is being closed by three layers of sutures.

and loosens the bowel as far as the promontory of the sacrum (Figure 159) The fascial bands above the levatores containing the middle hemorrhoidal vessels should be caught and tied (Figure 160) The prostate or vagina is now separated from the rectum in front, and while the rectum is being held toward the sacrum, the peritoneum is incised in front of the bowel (Figure 161) The bowel can now be pulled down so that the superior hemorrhoidal vessels if not already tied, may be caught and ligated (Figure 162) The ureters, which enter the bladder just above the seminal vesicles should be watched for and avoided as the peritoneum is opened. The bowel can now be brought down until at a point well above the growth, the peritoneum is sutured to the sigmoid to re-establish the floor of the pelvis. Clamps are placed on the bowel at the point chosen for section, and after packing off the field the bowel is severed between them Now using silk, the open end of the bowel is closed in layers (Figure 163) the large wound is lined with rubber tissue, and this is packed with loose gauze. This operation, while it probably does not give as wide removal of the lymph glands as is desirable and is practical only for tumors situated low in the rectum, entails less risk than the more radical abdominoperineal resection.

Babcock Bacon Method

The abdominal operation is begun by making a long left inguinal muscle-splitting incision, the abdomen is thoroughly explored to rule out metastases, and, if none are found, the lateral leaf of the mesosigmoid is divided and the sigmoid is rolled inward exposing the left ureter and the iliac and spermatic vessels. The peritoneal incision is continued around in front of the sigmoid behind the bladder and the inferior mesenteric or superior hemorrhoidal vessels are identified on the medial side of the sigmoid just below the bifurcation of the aorta and ligated and cut. If necessary the middle hemorrhoidal vessels may also be ligated. The rectum is mobilized in the hollow of the sacrum down to the sacrococcygeal articulation behind and the prostate gland in front. The mesosigmoid is cut well above the level of the tumor and at this point a piece of gauze is tied around the bowel, the proximal limb of the loop being identified by a black thread. The gauze attached to the bowel is packed down into the hollow of the sacrum, and on top of this the freed bowel is laid. No peritonealization is done and the abdomen is closed without drainage.

The perineal phase of the operation is begun by packing the rectum with iodine gauze but the anus is not sutured. The anus is grasped by four equidistant Allis forceps and pulled open The anal skin is incised just distal to the pectinate line and the sphincter muscle is identified and retracted away from the bowel. Working through the anal opening the rectum is mobilized posteriorly by a transverse incision in the fascia propria, which is attached to the periosteum of the sacrum. Traction is made

on the bowel and as the levatores are placed under tension they are clamped, cut and tied. The lateral ligaments are usually divided during the abdominal operation but if not they are clamped, cut, and tied. The rectum is carefully separated in front from the prostate seminal vesicles and bladder in the male and the vagina in the female. The sigmoid and rectum being freed, they are drawn through the anal opening until the marked segment above the lesion is well beyond the skin margin. The pelvic floor is re-established anteriorly and laterally A curved perforated metal drain is inserted between the bowel and the anal opening so that its tip lies in the hollow of the sacrum The bowel is cut off well beyond the skin margins, and a rubber tube is inserted into it. The metal drain is removed in forty-eight hours and the rubber tube is taken out of the bowel after the first bowel movement.

The operation is modified in some cases by making an incision between the tip of the coccyx and the posterior margin of the anus. This incision provides more working space for freeing the bowel in the pelvis.

POSTOPERATIVE CARE

A transfusion is given to the patient immediately after he has been placed in bed unless sufficient blood has been given during the operation. Liquids are withheld by mouth for forty-eight hours or until gas has been passed through the colostomy if one has been made. Five per cent glucose in saline is given intravenously or by hypodermoclysis in an amount of at least 3000 cc. per day Gastric suction or a Miller Abbott tube may be used to control upper abdominal distention or vomiting Penicillin is given in large doses every three hours, either intramuscularly or in the intravenous fluid. Catheterization should be done as required, and prolonged drainage is sometimes indicated because of paralysis of the bladder Morphine is given for pain, and the patient is turned freely in bed to aid in preventing pulmonary congestion. A light diet is given as soon as bowel movements have begun.

After a colostomy has been opened it may occasionally be necessary to irrigate it. This is done by passing a large lubricated catheter into the bowel, through which a warm soap solution is injected with a bulb syringe. No force should be used in inserting the catheter and no extreme pressure should be used in the injection. When the solution starts to come out or after a pint has been injected, the open end of the catheter is placed in a basin and the fluid allowed to escape. When a two-stage operation has been done, the lower segment of bowel is irrigated three times a day with plain water using a catheter as described above

After the packing has been removed from the site of a perineal operation, the wound is irrigated twice a day with 1 10,000 solution of potassium permanganate. Stenosis following a resection in which the rectal sphincters are preserved is corrected by daily dilatation with the finger

and in some cases a posterior incision may be necessary Prolapse of the bowel after colostomy although usually not of serious consequence, may make necessary linear cauterization or excision of part of the mucous membrane of the protruding bowel.

When the patient with a colostomy is ready to leave the hospital, he should be instructed in its care. After a bowel movement, the surrounding skin is cleaned and a dressing of fluffed gauze is applied and held in place by an abdominal belt This is usually more satisfactory than a rubber colostomy pouch because the gauze can be discarded, also, rubber pouches even with the best of care usually retain some odor and tend to irritate the skin, besides predisposing to hernia. The patient is instructed to take an enema by injection with a catheter through the colostomy each day If this is done and a diet is followed that will be somewhat constipating and will not predispose to gas, he should get along with the minimum of discomfort.

CHAPTER XXI

The Rectum and Anus

The Rectum and Anus

Investigation of the rectum includes digital examination and insp by means of anoscope and procto-sigmoidoscope. X ray examinati means of a barium enema is an unreliable method of diagnosing l of the lower bowel. Operations on the rectum and anus may be perf in any of three positions. The most commonly used position is litho with the patient on his back, the feet in stirrups, and the buttock down over the lower end of the table. The Sims position, in whi patient lies on his left side with the left arm behind the back, the rotated so that the chest is flat on the table and the knees and hips the right more than the left, is most comfortable for the patient awkward for the assistant, since he must hold up the right buttoc jack knife position, with the patient prone on the table and the broken so that the head and feet are lowered, has the advantages creasing soiling and bleeding, and making the bowel fall away fro pelvis so that the rectum balloons out.

PREOPERATIVE PREPARATION

Except in the case of an emergency such as an abscess, the p should enter the hospital the evening before operation. At this tin perineal region is shaved and a cleansing enema is administered usual physical examination and routine laboratory procedures ar formed.

LESIONS OF THE RECTUM AND ANUS

Cryptitis and Papillitis

About 3 cm. above the anal orifice the stratified squamous epith of the anal canal ends at the pectinate or anorectal line and the m membrane of the rectum begins. The latter is gathered into longit folds known as the columns of Morgagni between the bases of whi thin folds of skin known as the semilunar valves and behind each

is a small pocket known as a crypt of Morgagni Arising from the bases of the columns of Morgagni are several small triangular projections known as papillae. When a fenestrated anoscope is inserted into the rectum the crypts can be explored by inserting the point of a blunt hook and pulling down the semilunar valve The crypts are often the site of inflammation from which originate most cases of perirectal and ischiorectal abscess and fistula in ano

Inflammation of the papillae causes them to enlarge and elongate and sometimes they develop a polypoid nodule at the tip

Fissure in Ano

An ulcerated crack in the anal mucosa known as a fissure may result from infection of a crypt of Morgagni or from injury to the lining of the anal canal. The trauma must be of the recurring type, so that the lesion is prevented from healing until it has the characteristics of an elongated sluggish ulcer Associated with the fissure there may be a protuberance of the anal skin at the lower end which is known as a sentinel pile

Abscesses

Following a break in the rectal mucosa, an abscess may form in the perianal region or in the ischiorectal fossa. Eventually such an abscess perforates through the skin in the region of the anus or into the lumen of the rectum. An ischiorectal abscess usually originates from a primary infection in one of the anal crypts, and rupture of the abscess frequently results in an anal fistula. Occasionally an ischiorectal abscess of one side may spread to the fossa on the other side, and when these rupture 'horseshoe fistulas result. Abscesses also occur although rarely above the level of the levatores and may be located between the rectum and the prostate between the rectum and sacrum, or under the mucosa of the rectum.

Fistula in Ano

As a result of the rupture of an abscess in the ischiorectal or perirectal region, a fistula may develop and the enlarged papilla that marks the site of the inner opening is easily recognized. A probe can usually be passed without difficulty into the fistula from the outside, and in most cases it will appear in one of the anal crypts, but sometimes the tract takes a tortuous course with ramifications. In other cases, starting from a single opening in the anal or rectal mucosa, the tract may divide and have two or more external orifices on either side or both sides of the anus.

Fistulas and abscesses in the region of the rectum are occasionally tuberculous.

Stricture

Narrowing of the lumen of the rectum may be the result of operative procedure, congenital deformity injury of the mucosa, or inflammation,

The Rectum and Anus

Investigation of the rectum includes digital examination and inspection by means of anoscope and procto-sigmoidoscope. X ray examination by means of a barium enema is an unreliable method of diagnosing lesions of the lower bowel. Operations on the rectum and anus may be performed in any of three positions. The most commonly used position is lithotomy with the patient on his back, the feet in stirrups, and the buttocks well down over the lower end of the table. The Sims position, in which the patient lies on his left side with the left arm behind the back, the trunk rotated so that the chest is flat on the table and the knees and hips bent, the right more than the left is most comfortable for the patient but is awkward for the assistant, since he must hold up the right buttock. The jack knife position with the patient prone on the table and the table broken so that the head and feet are lowered, has the advantages of decreasing soiling and bleeding, and making the bowel fall away from the pelvis so that the rectum balloons out.

PREOPERATIVE PREPARATION

Except in the case of an emergency such as an abscess, the patient should enter the hospital the evening before operation. At this time the perineal region is shaved and a cleansing enema is administered. The usual physical examination and routine laboratory procedures are performed.

LESIONS OF THE RECTUM AND ANUS

Cryptitis and Papillitis

About 3 cm. above the anal orifice the stratified squamous epithelium of the anal canal ends at the pectinate or anorectal line and the mucous membrane of the rectum begins. The latter is gathered into longitudinal folds known as the columns of Morgagni between the bases of which are thin folds of skin known as the semilunar valves, and behind each valve

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Fistulas and abscesses in the region of the rectum are occasionally tuberculous.

Stricture

Narrowing of the lumen of the rectum may be the result of operative procedure, congenital deformity injury of the mucosa, or inflammation,

and is easily felt by the examining finger Any of the ulcerative inflammatory diseases of the rectum such as ulcerative proctocolitis, tuberculosis syphilis, and lymphopathia venereum, may at one stage or another result in narrowing of the rectum.

Anomalies

The anus may be congenitally absent or occluded and, as mentioned above narrowing of the rectum may be present. The bowel in some of these cases opens into the bladder vagina, uterus, or urethra.

Injuries and Foreign Bodies

Foreign bodies of many varieties and surprising size have been inserted into the rectum either accidentally or intentionally Glass tumblers electric light bulbs, and other objects too numerous to mention have been reported. Stretching of the rectum caused by the insertion of the object or too forcible probing in the attempt to remove it may cause tearing of the wall of the bowel.

One of the most serious types of rectal injury is that produced by the accidental blast of an air hose in the region of the anus.

Prolapse

Prolapse of the rectum consists of the protrusion of the rectal mucosa only The more severe degree, procidentia, is the descent of all the coats of the bowel The condition is most frequently seen in children, and is associated with diarrhea or straining at stool. In the adult it is more commonly associated with hemorrhoids, and in the aged it may be due to loss of tone of the sphincter

Hemorrhoids

These are divided into external and internal the former being those covered with anal skin. An internal hemorrhoid always originates above the anorectal line. The common complications are prolapse and thrombosis.

Benign Tumors of the Rectum and Anus

The most common benign tumor in this location is a simple adenoma or adenomatous polyp It is usually smooth and sessile or pedunculated. Warty growths or papillomata are also seen and should be distinguished from the condylomata found in the anal skin. Other rare tumors are the fibroma, lipoma, and angioma.

Malignant Tumors

The only common malignant tumor of the anus and rectum is carcinoma. Epidermoid carcinoma occurs in the skin of the anus and anal

canal In other locations adenocarcinoma is the usual variety Epidermoid carcinoma appears as a firm thickening of the skin which has a tendency to break down early discharge serous fluid, and crust over Carcinoma in the rectum may be scirrhous or encephaloid. The latter type has a tendency to bleed and ulcerate early Malignancy may also develop in a benign tumor such as an adenomatous polyp Carcinoma of the rectum passes by way of the pararectal glands to the glands in the sigmoid mesocolon and from there to the preaortic glands near the origin of the inferior mesenteric artery Carcinoma of the anal canal metastasizes to the lymph glands along the course of the middle and inferior hemorrhoidal arteries, and then to the hypogastric glands. Metastasis from carcinoma of the anus takes place first in the superficial inguinal glands. It may also metastasize to the obturator and hypogastric glands.

TREATMENT AND TECHNIQUE

Cryptitis and Papillitis

With the use of a fenestrated anoscope a hook is inserted into the infected crypt and, with the help of a hemostat the roof of the crypt is removed with scissors If any overhanging edges remain, these are trimmed away When papillitis is present the enlarged papilla is grasped with a hemostat or forceps and snipped off with scissors (Figure 164B)

Fissure in Ano

When conservative treatment has failed, the ulcer in the mucous membrane is excised along with a small margin of the normal mucous membrane around it (Figure 164A) and a portion of perianal skin. The operation may be combined with hemorrhoidectomy or fistulectomy

Abscesses

Subcutaneous abscesses are incised at the point of greatest fluctuation or induration.

An ischiorectal abscess should be opened if possible by a radial incision just outside the external sphincter but if the abscess is too far from the surface at this point, the incision may be made farther away from the anus. A finger should be inserted into the abscess and partitions found should be broken down. The skin incision should be enlarged enough to make drainage free and rubber drains unnecessary

An abscess above the level of the levatores should be drained by an incision through the ischiorectal fossa The levator muscle is penetrated by blunt forceps and, when pus is obtained, the opening is enlarged and a soft rubber drain inserted.

A submucosal abscess of the rectum should be opened through the mucous membrane.

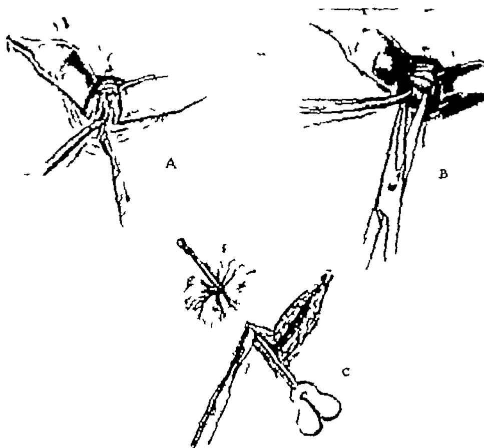


FIG. 164 A. *Excision of fissure.* B *Excision of hypertrophied papilla* C *Op tract of a fistula.*

Fistula in Ano

The anorectal line is exposed by a speculum, and a blunt pro grooved director is introduced into the external opening By gentle sure it can usually be made to appear through the internal opening crypt or elsewhere The director should be so manipulated that it right angles to the external sphincter with a knife, an incision is through skin sphincter and anal wall down to the grooved di (Figure 164C) The latter is now removed and the base of the fist tract is curetted. In some cases the probe cannot be passed throug internal opening but if it approaches the mucous membrane near a it may be pushed through and the fistula incised from there

In other cases it may be necessary to inject a dilute solution of me ene blue to outline the course of the fistula, and then with or with probe in the tract, it is cored out down to its origin in the rectum. a branching fistula is present the grooved director should be introd and the skin opened down to the tract whatever its course (F 164C) but the sphincter should be cut through only once and th right angles Most fistulas open into the bowel distal to the int

sphincter, but if one should enter higher up both the internal and external sphincters must be cut to cure it. Unless both sphincters are cut in the posterior midline, the internal sphincter should be sutured after excision of the fistulous tract to prevent incontinence. If in order to expose all the tract it is necessary to cut through the sphincter at more than one point, the first incision should be allowed to heal and the other tract or tracts exposed at a subsequent operation.

Stricture of the Rectum

This should be treated by gradual dilatation unless a membranous partition is present which can be incised.

Anomalies

In imperforate rectum the partition should be incised and the rectum dilated. When there is agenesis of the rectum and anus, an incision should be made and the lower end of the rectum brought down and sutured to the skin. If the bowel is not long enough to permit this an inguinal colostomy must be done. If the rectum opens into the vagina, bladder urethra, or other abnormal location, when the child becomes at least three years old a temporary colostomy should be performed, and a plastic operation done to transplant the end of the rectum to the perineum.

Foreign Bodies

These should be removed by manipulation. In rare instances division of the sphincter may be necessary If the object cannot be extracted through the anus, it should be pushed upward by a rectal tube and removed by laparotomy and incision in the sigmoid. The opening in the sigmoid should be made parallel to the bowel and closed in a transverse direction by two or three layers of sutures.

Prolapse

In children the prolapse is reduced manually and no other treatment is necessary In the adult, reduction of the prolapse is performed, and any anal abnormality that led to it should be corrected. If the mucous membrane does not remain in place after reduction linear cauterization of the mucosa may be sufficient to keep it up In other cases the Rehn Delorme operation may be indicated. An incision is made around the prolapsed bowel at the mucocutaneous line. The mucosa is then stripped off like a glove (Figure 165A) and longitudinal sutures are inserted in the muscularis so that when they are tightened the muscular coat will be puckered (Figure 165B) When these sutures are tied, the apex of the prolapse is brought near the anorectal line. The excess denuded mucosa is cut off the segment is replaced, and the free edges of the mucous membrane are sutured to the skin (Figure 165C and D)

Moschcowitz's operation, which necessitates opening the abdominal cavity may be performed if the procedures outlined above are ineffective. The object of this operation is to obliterate the pouch of Douglas and thus prevent the small intestine from passing downward and exerting pressure on the anterior rectal wall The abdomen is opened by a lower midline incision, and, with the patient in a Trendelenburg position, the

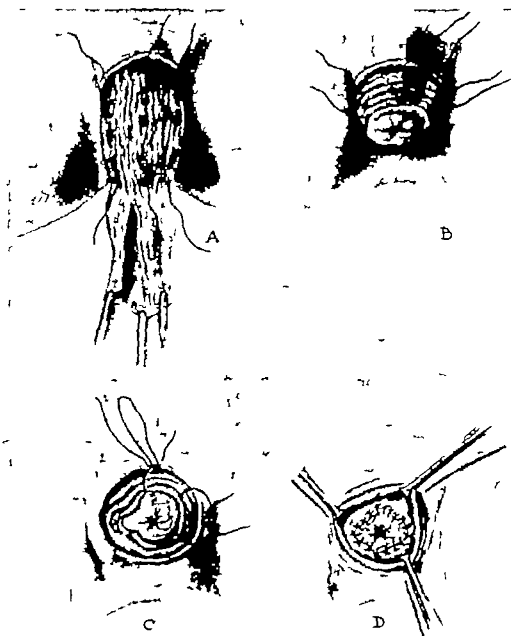


FIG. 165 *Prolapse of the Rectum.* A. The mucous membrane of the prolapsed segment has been stripped off and a series of sutures has been introduced to draw up the muscular coat B The sutures are being tied. C. Two sutures have been inserted to contract the muscular coat in the region of the anus, and the skin of the anal margin is being sutured to the surrounding skin. D The suture line has been completed.

sigmoid colon is put under tension and a series of catgut sutures is introduced in a pursestring fashion to close the cul-de-sac. The pelvic fascia over the levatores and the supravaginal portion of the cervix of the uterus are included in the sutures, which should number from six to eight. Care should be used not to include the ureters or the uterine blood supply in the sutures.

Hemorrhoids

An acutely inflamed or necrotic external hemorrhoid that requires immediate attention is incised so that the clot can be expressed. A portion of the roof of the pile is excised with scissors to keep the clot from reforming

Internal hemorrhoids may be palliated by the injection method if desired, using 5 per cent quinine and urea hydrochloride. The injection is made under the mucous membrane above the hemorrhoid and should not enter the vein of the hemorrhoid. Not over 2 cc. should be injected at one time, and not more than three places should be injected at one sitting.

Hemorrhoidectomy The hemorrhoid is grasped near the skin border with a hemostat, another hemostat is applied to the hemorrhoid farther up and an incision is made through the skin around the base of the hemorrhoid (Figure 166) Another hemostat is applied in this incision (Figure 167) and the hemorrhoid protruding above it is cut off A con

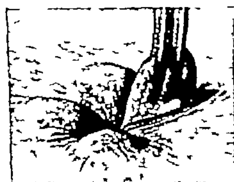


Fig. 166 *Hemorrhoidectomy* The hemorrhoid has been grasped by forceps and an incision has been made through the surrounding skin and mucosa.



Fig. 167 *Hemorrhoidectomy* A clamp is applied to the hemorrhoid.

tinuous running stitch is applied under the clamp and is tightened as the clamp is removed (Figure 168) If desired the hemorrhoid may be removed by the cautery in which case after the base of the hemorrhoid has been incised, a special wide clamp is applied. After protecting the surrounding tissues with moist gauze the protruding part of the hemorrhoid is burned off. This process is continued around the circumference

of the anus as required, but care is taken to leave a strip of mucous membrane and skin between each excised segment to prevent stenosis.

Hemorrhoidectomy may also be performed by the technique first described, but omitting the use of the clamp Bleeding is controlled by suture and ligature. At the conclusion of the operation a Penrose drain is inserted into the rectum. If hemostasis is not perfect the rubber may be wrapped with absorbable gauze.



FIG 168 *Hemorrhoidectomy* Sutures are being inserted under the clamp.

Benign Tumors

These should be removed by excision or electrocoagulation done through the proctoscope. In most cases, a snare can be applied around the tumor and after the tumor is removed, the base cauterized.

Malignant Tumors

Epidermoid carcinoma of the anus may be treated by the application of radium but the results are better with wide surgical excision. The Lockhart Mummery principle is utilized, and the inguinal glands should be removed if involved. Adenocarcinoma of the rectum should be treated by removal of the rectum, either by the abdominoperineal route or if the tumor is low down, using the Lockhart Mummery method as described under carcinoma of the colon (page 453)

POSTOPERATIVE CARE

After most rectal operations hot wet compresses of boric acid applied to the perineum are soothing and promote healing Morphine is given for pain and a liquid diet is permitted as soon as nausea has subsided. If a pack has been used after incision of a fistula it is removed in forty-eight hours and thereafter the wound is cleaned and inspected daily If bridging is noted the granular adhesions are cut. One-half to one ounce of liquid petrolatum is given nightly after the first day but this should be

discontinued or reduced in amount after the first week, so that the stools are firm and formed and act as anal dilators. On the third day after operation, a saline enema is administered, using a small catheter Sitz baths are given two or three times a day during the first week after operation. A finger should be inserted into the rectum on about the fifth day to be sure that no stenosis is present. Postoperative hemorrhage can be controlled by inserting a pack of absorbable gauze.

CHAPTER XXII

The Uterus, Fallopian Tube, and Ovary

PREOPERATIVE PREPARATION
INCISION
EXPLORATION
THE UTERUS
  Anomalies
  Injuries of the Uterus
  Displacements of the Uterus
  Inflammation
  Tumors of the Uterus
THE FALLOPIAN TUBE
  Congenital Abnormalities
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THE OVARY
  Anomalies
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  Simple Cysts
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TREATMENT
  The Uterus
  Displacements of the Uterus
  Inflammation
  Benign Tumors of the Uterus
  Malignant Tumors of the Uterus
  The Fallopian Tube
  The Ovary

TECHNIQUE
- Suspension of the Uterus (Baldy Webster Method)
- Myomectomy
- Cesarean Section
- Subtotal Abdominal Hysterectomy
- Total Abdominal Hysterectomy
- Wertheim's Panhysterectomy
- Vaginal Hysterectomy
- Salpingectomy
- Oophorectomy
- Salpingo-Oophorectomy
- Partial Resection of the Ovary
- Dilatation and Curettage
- Cauterization of the Cervix
- Removal of Cervical Polyp
- Trachelorrhaphy
- Amputation of the Cervix

POSTOPERATIVE CARE

The Uterus, Fallopian Tube, and Ovary

Operations on the female pelvic organs easily constitute one fourth of the usual surgical practice and if competently done they carry a low morbidity and mortality

PREOPERATIVE PREPARATION

Secondary anemia is frequent in patients who require pelvic surgery and transfusions are given if indicated by the blood count and hemoglobin determination. An enema should be administered the night before operation and the bladder should be emptied by catheterization just before surgery The usual preoperative sedative is given. In patients who are to have an operation in which the vagina is to be opened or which is to be performed through the vagina, the vaginal secretions should be removed by a swab and the interior of the vagina should be painted with an antiseptic, such as tincture of merthiolate when the patient is on the operating table.

INCISION

The abdomen is opened by a midline incision extending between the symphysis pubis and the umbilicus. If it is necessary to obtain more exposure the incision is extended upward along the left side of the umbilicus. The fascia between the rectus muscles is incised, the muscles are separated, and the peritoneum is opened first in the upper part of the wound. Even though the patient has been catheterized preoperatively if an attempt is made to open the peritoneum in the lower part of the wound the bladder may be inadvertently opened. If this accident should occur the bladder is grasped with Allis forceps on each side of the wound and the opening is closed by two layers of fine catgut sutures The peritoneum having been opened, the surgeon inserts two fingers and extends the peritoneal incision upward as far as possible. Then, with the help of an assistant, the peritoneal opening is enlarged downward, using the greatest of care to avoid cutting the bladder In order to obtain the best access

to the pelvis, the rectus and pyramidalis muscles should be separated as far down as the bone of the symphysis, but the leaving of sufficient uncut peritoneum in the lower margin of the wound to protect the bladder will not interfere with the exposure.

EXPLORATION

If when the peritoneum is opened a large amount of blood pours out of the abdominal cavity one may be dealing with a ruptured ectopic pregnancy or a tear or wound in the uterus. The presence of bloody fluid may indicate a strangulated ovarian cyst, hemorrhagic pancreatitis, or strangulated bowel. A ruptured Graafian follicle often produces a small amount of blood in the peritoneal cavity but seldom in sufficient amount to be evident when the peritoneal cavity is opened. The presence of serous peritoneal exudate is indicative of inflammation or strangulation, and its source should be found before a general abdominal exploration is conducted. Disease of the tubes and ovaries is usually responsible for pelvic peritonitis, but when increased serous fluid or serofibrinous exudate is found, inflammation of the appendix, diverticulitis, strangulated bowel Meckel's diverticulitis, and inflammatory lesions in the upper abdomen should be kept in mind. The surgeon who always stands on the left side of the patient in a pelvic operation inserts his left hand into the pelvis to examine the uterus and appendages. The uterus including the cervix, is palpated and the hand is then passed from each cornu of the uterus out along the tube to the ovary on each side. The size, position, and consistency of the uterus and appendages are noted and the presence or absence of adhesions determined. In pelvic inflammatory disease, the pelvic structures are frequently found to be matted together and no attempt should be made to separate them until the field has been properly prepared. If an infected area is present but well walled off a general abdominal examination can be safely conducted. The left hand grasps the cecum and pulls it into the wound so that the appendix can be examined. The hand is then passed up to feel the gallbladder liver stomach duodenum, and pancreas. The size of the spleen is determined, and the size and position of the kidneys are noted. Any abnormal mass or band is brought into the wound if possible for visual examination. A self retaining retractor of the Balfour type is now inserted into the wound, and the detachable blade is adjusted so as to pull up the peritoneum in the lower angle of the wound. The patient is placed in the Trendelenburg position, and the coils of small bowel and colon are packed out of the way With proper depth of anesthesia, the small intestine can be packed up high enough to allow liberal working space in the pelvis. A tenaculum or towel clamp is now applied to the fundus of the uterus, and it is pulled upward into the wound.

THE UTERUS

Anomalies

Bicornate and Duplex Uterus Incomplete fusion of the two Müllerian ducts may result in various degrees of abnormality of the uterus. The uterus may be double, with a double cervix and vagina, or it may be double, but have a single cervix with two cervical canals and a single or double vagina. Failure of absorption of the septum between halves of the uterus, cervix, and vagina may result in a partition in any of these regions and the uterus in such cases appears to have a depression in the top of the fundus. Pregnancy may occur in either side of a double uterus, and even in both sides at once.

Unicornate uterus is an abnormality found usually only in a non-viable fetus, and which is associated with unilateral absence of the tube and ovary

Uterine Pregnancy With the advance of pregnancy, the uterus gradually increases in size. During the first few weeks the pyriform shape is retained but the body and fundus gradually assume a globular form, so that at the end of the third or fourth month the uterus becomes almost spherical. From this point on, however, the organ increases rapidly in length and assumes the oval form that persists until the termination of pregnancy The cervix becomes softened early in gestation, the vascularity of the pelvic organs is strikingly increased, and the wall of the uterus gradually becomes thinner so that at the end of the fifth month the uterine wall is only about 4 mm. thick. At the end of the fourth month the uterus has become too large for the pelvis and extends half way between the symphysis pubis and the umbilicus. At the fifth month the fundus reaches the level of the umbilicus, and it has displaced the intestine to the sides of the abdomen so that it comes in contact with the anterior abdominal wall, and, due to elongation of the broad ligaments becomes rather mobile. The uterus at term reaches almost to the liver and has a tendency to rotate slightly on its long axis, usually to the right. The tubes and ovaries partake of the increased vascularity and the tubes come to lie almost parallel to the sides of the uterus. The single large corpus luteum of pregnancy can usually be found on the surface of one of the ovaries.

In most cases, the symmetrical enlargement of the uterus, the deepened color due to the increased blood supply and the large corpus luteum leave no doubt of the diagnosis, but in exceptional cases, without the use of a pregnancy test the diagnosis may be very difficult. As the uterus enlarges it becomes softer but a uniform soft enlargement may be seen in adenomyosis or in any tumor of the uterus that has not destroyed the nor

mal uterine outline. I have seen for instance sarcoma of the uterus with degenerative changes that almost exactly duplicated in appearance and consistency the five months pregnant uterus. When gestation is well advanced the diagnosis is quite evident, but in the early stages, if fibromyomata are present, it may be difficult or impossible to tell that the enlargement of the uterus is not due to fibromyomata alone. The coexistence of pregnancy and fibromyomata in a woman of the child bearing age should always be kept in mind as a possibility and the appropriate tests should be made before operation is performed.

When the uterus is of fairly good size but not large enough so that the fetus can be felt, and one is unable to decide whether one is dealing with a tumor or pregnancy it may be justifiable in some cases to cautiously insert a needle through the uterine wall in the search for amniotic fluid.

Injuries of the Uterus

Perforation of the uterus This is not a rare accident in criminal abortion and may occur in the course of a diagnostic curettage. If no infection is present in the uterine cavity and the operation has been done with sterile precautions, no symptoms may be produced. In many cases, however an abortionist does not realize that the accident has occurred and the scraping is continued until the opening is enlarged and even pieces of bowel, which have herniated into the uterine cavity are torn out. In such cases, overwhelming infection rapidly develops and the patient dies of generalized peritonitis. Perforation of the uterus may also be caused by unskilful attempts at instrumental delivery

Lacerations of the Cervix Small tears of the cervix are an almost constant accompaniment of childbirth, but in most cases they are so slight as to be of no significance Occasionally deep cervical tears may occur either during spontaneous labor or instrumental delivery or as a result of instrumental or manual dilatation of the cervix and may extend to the lower uterine segment or up to the base of the broad ligament and be associated with severe hemorrhage The cervix of the nongravid uterus may also be torn during forceable dilatation with an instrument as a preliminary to curettage for diagnostic purposes.

Rupture of the Uterus This accident, which is fortunately rare may occur at any time during pregnancy but is most apt to take place during labor When rupture occurs during the first half of gestation it is said to be due to unusually deep invasion of the uterine wall by the placenta, or to pregnancy occurring in the interstitial portion of a tube or in a bicornate or infantile uterus. Rupture in the later months of pregnancy may be caused by previous injury to the uterine wall by cesarean section. Rupture during labor is apt to be associated with contracted pelvis neglected transverse presentation, or other unfavorable presentations, or an abnor

mally large child or one with hydrocephalus. A rupture occurring during labor is usually confined to the lower segment and is commonly associated with extrusion of the child into the abdominal cavity and alarming hemorrhage. In rare instances when rupture occurs early in pregnancy the placenta may remain in the uterus or may be extruded and become attached elsewhere, and the child may go to term as an intra abdominal pregnancy

Displacements of the Uterus

Retroversion and Retroflexion Retroversion, which is the backward angulation of the uterus including the cervix, and retroflexion which is the bending backward of the body of the uterus only are common lesions and in most cases produce no symptoms. When the uterus is larger than normal and there is considerable relaxation of the uterine supports, the symptoms may be severe and lesser degrees of retroversion may result in sterility

Prolapse and Procidentia Sagging of the uterus into the vagina associated with stretching of the broad and uterosacral ligaments is common in older women who have borne children. The cervix may protrude from the vagina and, in extreme cases, known as procidentia, the entire uterus with the inverted vagina may project from the introitus

Inflammation

Acute Endometritis Acute inflammation of the endometrium is very common, particularly after criminal abortion. It may also follow child birth, it may be initiated by the insertion of a stem pessary or may be caused by gonorrheal infection. There is sloughing of the mucous membrane and a foul smelling discharge

Chronic Endometritis This condition is infrequently seen except when due to tuberculosis. The uterus is not rarely affected by tuberculous lesions, with tubercles forming primarily in the endometrium. Tuberculosis of the uterus is usually associated with tuberculous salpingitis and tuber culous tubo-ovarian abscess, the whole picture resembling closely that produced by a gonorrheal infection.

Cervicitis Inflammation of the cervix is common as a result of gonor rhea, infection following childbirth, abortion, instrumentation, et cetera. The primary focus of the disease is usually the cervical canal (endocer vicitis) and the inflammation of the vaginal cervix is maintained as a secondary process. Cervicitis is commonly accompanied by retention cysts of the cervical glands (nabothian cysts) mucosal polyps due to overgrowth of the mucosa, and erosion and is sometimes followed by stricture of the cervical canal. Deep lacerations of the cervix may be fol lowed by eversion of the cervical mucosa, and this should be distinguished from erosion.

Tumors of the Uterus

Fibromyoma The myoma or fibromyoma is the commonest tumor of the uterus and is usually classified by its location as subserous, interstitial, or submucous. The first two varieties, when large enough, produce distortion and deformity of the uterus. The submucous type, on the other hand, grows into the uterine cavity and may even project from the cervix as a pedunculated mass. The tumors are commonly multiple, hard, white in color and rounded in shape, but degeneration may take place in the interior of a tumor so that it becomes softened and may feel cystic. A subserous fibroid may become pedunculated, and twisting of the pedicle may cause a sudden interruption of the blood supply and strangulation of the growth. Fibromyomata may occur in the cervix, where they constitute a grave danger in pregnancy and the tumors sometimes develop also in the broad ligament. They grow rather slowly but may ultimately produce an enormous mass, which fills the pelvis and extends high above the umbilicus and not uncommonly becomes adherent to the omentum over a large part of its surface. Uterine bleeding and pressure symptoms are commonly present. In a fraction of 1 per cent of the cases, sarcomatous metaplasia occurs, but unless metastasis has taken place it is rarely possible to diagnose the sarcoma until the tumor has been sectioned.

Adenomyoma A tumor grossly resembling fibromyoma but which contains glandular tissue along with the fibrous stroma is known as an adenomyoma. These tumors are not definitely encapsulated but may have the same subserous, interstitial, and submucous locations as the fibromyomata, and may be pedunculated, extending into the uterine or peritoneal cavities. They may become strangulated and undergo degeneration, and may be the cause of uterine bleeding In rare cases carcinoma may develop from them.

Diffuse adenomyomata of the uterus sometimes occur as an infiltrating process that causes uniform enlargement of the uterus, so that it may be two or three times normal size and yet present none of the nodules or the deformity associated with the development of tumors. This condition, known as adenomyosis, may resemble grossly subinvolution of the uterus, but microscopically myomatous tissue is seen to be penetrated by masses of endometrial tissue the latter often containing cystic spaces filled with chocolate-colored fluid, thus representing a form of endometriosis.

Carcinoma of the Cervix This tumor which is usually of the squamous-cell type but may occasionally be an adenocarcinoma begins on the cervix or in the cervical canal as an area somewhat paler in color than the surrounding tissue extends diffusely under the mucosal surface causing an enlargement of the cervix, and eventually sloughs and leaves a ragged ulcer In other cases it begins as a papillomatous outgrowth from the cervix that gradually enlarges to form a huge cauliflower like mass, and in

still other cases the original lesion may ulcerate to form a flat ulcer that spreads peripherally All of these lesions bleed easily when touched by the examining finger· this is their most striking characteristic. The tumor spreads most commonly by way of the lymphatic spaces in the connective tissue backward to the uterosacral ligament, up into the broad ligament to the rectum and downward in the vaginal wall. Carcinoma of the cervix metastasizes to the lymph glands at the base of the broad ligament and into the iliac, hypogastric, and sacral groups and in advanced cases meta stasis may take place by way of the blood stream.

Carcinoma of the Body of the Uterus The growth, which is an adeno-carcinoma, arises from the endometrium commonly in the region of the fundus and tends to produce a large cauliflower like mass in the uterine cavity without deep extension into the wall of the uterus. In more advanced cases the muscular wall may of course become deeply infil trated and the uterus may become moderately enlarged, the enlargement often being symmetrical so that the organ shows no gross deformity Car cinoma of the body of the uterus does not have the strong tendency to lymphatic permeation possessed by carcinoma of the cervix, and the uterus does not have the same tendency to become fixed by the advance of the growth. Metastasis may occur however to the lymph glands along the vertebral column and in late stages by way of the blood stream in other cases, fragments of the growth may pass out through the Fallopian tubes and cause carcinomatous growth on the ovaries. The fragments obtained from the uterus by dilatation and curettage in carcinoma of the body of the uterus are usually considerable in amount and have a characteristic bread-crumb-like appearance.

Squamous-cell carcinoma of the body of the uterus may occur but is rare. Obstruction of the cervical canal may occur in carcinoma of the body of the uterus or in carcinoma of the cervix, and is followed usually by pyometria.

Sarcoma of the Uterus This tumor has already been mentioned as oc curring in fibromyoma, but primary sarcoma of the uterus although rare is not unknown. It may produce a diffuse enlargement of the uterus or may begin in the uterine wall and then become submucous and later pedunculated. A rare tumor of the uterus is a sarcoma that arises from the endometrium in the region of the cervical canal or cervix, and projects into the vagina in the form of a mass like a bunch of grapes. This is a highly malignant tumor and may occur at any period of life even in infancy Sarcoma of the uterus has some tendency to invade the para metrium but usually does not produce as dense fixation as does carcinoma of the cervix. In late stages, metastasis by way of the blood stream may produce secondary growths in the lungs liver and other organs.

Chorionepithelioma This tumor which may come on following preg nancy or abortion or after the passage of a hydatiform mole usually arises

in the uterus, although it may occur in the tube or ovary The growth begins in the uterine wall and extends into the uterine cavity so that there is a hemorrhagic mass present, which causes a moderate amount of enlargement of the uterus. Dark red nodules may appear on the surface of the uterus where the growth has extended through the wall. Metastasis takes place by way of the veins and secondary growths may occur in the lungs, liver and other organs. Not all chorionepitheliomata are highly malignant and some show considerable regressive tendency The syncytioma, a type of chorionepithelioma, does not metastasize and may disappear spontaneously It contains no Langhans cells, but is made up of masses of syncytial cells and necrotic tissue. Between this and the more malignant chorionepithelioma, less sharply defined intermediate varieties of the tumor exist.

Polyps These soft, red, pedunculated, benign tumors, which bleed easily are common in the canal of the cervix or the body of the uterus and may be single or multiple. The cervical type often protrudes from the cervix and may reach a diameter of 3 cm. or more It should be distinguished from a pedunculated fibroid, which is whiter in color and more firm. Multiple polyps of the endometrium are sometimes called polypoid endometritis.

Placental Rests Chorionic villi may survive in the uterine wall for long periods of time and as a result of fibrous proliferation may produce tumors of considerable size, which give rise to uterine hemorrhage. The mass is commonly pedunculated but may invade the uterine wall.

Hydatiform Mole Abnormal growths of the chorionic cells in pregnancy may result in the disappearance of the placenta and fetus, and the development of a tumor that consists of grape-like, translucent, rounded vesicular masses.

THE FALLOPIAN TUBE

Congenital Abnormalities

Congenital stricture of the tubes due to bands or kinking, and diverticula are common and may cause sterility There may be doubling of the entire tube or of the distal portion, and, on the other hand, congenital absence of a tube may occur this condition usually being associated with the absence of the corresponding uterine horn.

Embryonal rests developing from the parovarium, while not an abnormality of the Fallopian tube, may be conveniently mentioned here. Remnants of the Wolffian ducts located between the tube and the ovary frequently form small cysts, and the terminal tubule of the Wolffian body very often produces the hydatid cyst of Morgagni, a pedunculated cyst usually not larger than 1 or 2 cm. in diameter which is attached below the fimbriated end of the tube about half way between the tube and

ovary Other cysts may develop from remnants of the Wolffian ducts along the lateral border of the uterus between the leaves of the broad ligament, or even in the body of the uterus or in the vaginal wall.

Inflammation

Salpingitis is the most common affection of the Fallopian tube and is usually produced by the gonococcus but other organisms, the staphlococcus, the streptococcus the colon bacillus, the tubercle bacillus and more rarely the typhoid bacillus the pneumococcus, and the ray fungus may be the etiologic factor In the acute stage of the disease the entire tube is reddened, swollen, and edematous, and there is some increase in the amount of intraperitoneal fluid. Both tubes are usually affected, but the process may occasionally be farther advanced on one side than on the other As the inflammation continues, fibrin is deposited on the wall of the tubes and extensive adhesions take place between the tube and surrounding organs. In the early stage of inflammation pus can often be ex pressed from the open end of the tube, but in the later stage the lumen of the tube becomes sealed by the inflammation, and the pus no longer able to escape into the abdomen begins to distend the tube (pyosalpinx) The tubal plicae become necrotic and more or less destroyed by the in flammatory process. In pyosalpinx, the tube may vary in size from 1.5 to 6 or 7 cm in diameter and may be correspondingly lengthened and the wall thickened. Associated with the inflammation in the tube the infection may extend to the ovary with the formation of an ovarian abscess and the septum between the ovary and the tube may later break down so that the two collections of pus are joined into one (tubo ovarian abscess)

Many cases of acute salpingitis subside without the development of pyosalpinx, but the inflammation may be followed by obstruction of the lumen of the tube so that subsequently serous fluid may accumulate in the tube and distend it to an enormous size (hydrosalpinx) A tubo-ovarian cyst is formed by the coalescence of hydrosalpinx and a cystic ovary due to rupture of the dividing septum although in some cases such a condition may be the end result of a tubo-ovarian abscess, the purulent fluid having been absorbed.

In chronic inflammatory disease of the Fallopian tube, there is extensive development of fibrinous and fibrous adhesions, and the tubes become plastered to the uterus and sigmoid in the pelvis. As the inflammation continues, rupture of one or both tubes may occur with the for mation of a pelvic abscess. Such an abscess is usually well walled off by the previously formed adhesions and tends to extend downward into the cul-de-sac.

Salpingitis due to gonorrhea progresses primarily along the mucous surface of the tube from the uterus outward, but in infections due to the

staphlococcus, streptococcus or colon bacillus the extension of the di ease is usually along the serous surface and the infection is primarily perisalpingitis with involvement of the tube as a secondary conditio since these organisms usually reach the tube as an extension from diseas in a neighboring organ. Unilateral perisalpingitis thus is a common com plication of acute appendicitis Tuberculosis of the Fallopian tube may r semble gonorrheal salpingitis so closely that only microscopic examinatio will make the diagnosis possible. In some cases, however the caseous co tent of the tube or the presence of tubercles on the neighboring perit neum or areas of calcification make the nature of the condition eviden Peritoneal adhesions in tuberculosis are much denser than those seen i gonorrheal salpingitis in fact the absence of dense fibrous adhesions eve in long-standing infections is strikingly characteristic of infection due t the gonococcus as distinguished from all other types of infection.

Ectopic Pregnancy

A fertilized ovum may develop in a Graafian follicle of the ovar (ovarian pregnancy) at the fimbriated end of the tube (tubo-ovaria pregnancy) or within the ampullary isthmic, or interstitial portions c the tube. In tubal pregnancy which is much more common than ovaria the tube gradually hypertrophies, extravisation of blood occurs into th lumen, and the embryo usually dies at about the end of the second c third month. The embryo may then be absorbed, or a tubal mole ma form, or the contents of the tube may be passed out into the abdomin cavity (tubal abortion) or the tube may rupture and discharge its con tents the latter being the most frequent termination. Associated wit rupture of the tube there may be extremely severe hemorrhage into th abdominal cavity and symptoms of shock, but in some cases the bleedin may be limited in amount or may consist of repeated small hemorrhages In rare cases the placenta may become implanted on intra abdomina organs and pregnancy may go to term. Hematosalpinx may occasionall be seen when hemorrhage occurs into a hydrosalpinx, but when there i thickening of the tube and considerable blood, the condition is almos pathognomonic of tubal pregnancy

Tumors

Salpingitis Isthmica Nodosa This condition, which may be bilateral is characterized by the development in the uterine horn of inflammatory or adenomatous nodules.

Carcinoma Primary carcinoma of the Fallopian tube is rare. The growth begins in the endosalpinx, fills up all or a portion of the tube, and tends to protrude through the fimbriated end, where portions of the growth may be broken off and develop secondarily in the pelvis or on adjacent organs. Secondary carcinoma of the Fallopian tube may develop

from implants secondary to carcinoma elsewhere in the abdominal cavity

Adenomyosis Adenomyomatous changes may occur in the tubes or tubal stumps and be associated with endometrial implantations in the abdominal wall or on adjacent organs

THE OVARY

Anomalies

Absence of an ovary is rare but may be seen in conjunction with unicornate uterus. Accessory ovarian tissue or a third ovary is said to be not infrequent

Hermaphrodism True bisexuality is extremely rare but pseudohe maphrodism, under-developed sex organs and some characteristics of tl opposite sex is not uncommon.

Inflammation

Oophoritis may occur as an extension from inflammation of the tube or of a neighboring organ. The inflammation in the ovary may progress to the formation of an abscess, as has already been mentioned under salpingitis.

Simple Cysts

These are not true tumors and represent merely the distention of a normal structure. The follicular cysts occur as the result of accumulated fluid in an unruptured Graafian follicle. Although such cysts are usually multiple and small they may reach, in rare instances, a diameter of 8 or more cm. In some cases the contents may be chocolate or tarry in character due to the presence of blood in the fluid. Such a cyst with its chocolate contents should be differentiated from a corpus luteum cyst containing blood, and from the cysts seen in endometriosis. Corpus luteum cysts are usually single and are due to the accumulation of serous fluid in a corpus luteum. The wall shows the yellow color characteristic of the corpus luteum and the cyst is usually small but may become 6 or 7 cm. in diameter

Inflammatory Cysts of the Peritoneum

While these are not connected with the ovary they may be mentioned here because they are so commonly encountered in pelvic operations. Usually in the presence of a gonorrheal salpingitis or salpingo-oophoritis, multiple thin-walled sacs with serous or gelatinous contents may be seen attached to the ovaries or between the coils of bowel. They are ruptured very easily and disappear spontaneously when the etiologic factor is removed.

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Endometrial Cysts and Endometriosis

These occur as the result of the implantation of uterine epithelium on the ovary or within the ovary at a point of rupture of a follicle. The cysts are usually small but may reach the size of an orange and are often bilateral. The content of the cyst, due to the presence of blood, is chocolate-like or tarry in appearance, and if it reaches the abdominal cavity due to rupture of the cyst, implants having a raspberry or blueberry appearance may grow on the neighboring bowel or uterus.

Cystic Tumors

Cystadenoma The most frequent neoplasm of the ovary is the cystadenoma, a benign tumor that arises in the substance of the ovary and may reach enormous size. The cystadenoma may be unilocular or multilocular and may be lobulated or smooth on its surface. The contents may be a thin watery fluid (serous cystadenoma) or thicker and mucoid (pseudomucinous cystadenoma) In about 20 per cent of the cases the tumor is bilateral. In nearly all cases the cyst is freely movable although there may be minor adhesions between the cyst and the adjacent bowel. In some cases, however these adhesions may be very extensive and prolonged and careful dissection may be necessary in order to free the growth.

Papillary Cystadenoma Sometimes called papillary carcinoma, this is a tumor that resembles in gross external appearance the simple cystadenoma, except in those cases where an intracystic papilloma has grown through the surface of the cyst and presents as a warty growth. The tumor is multilocular and when sectioned shows intra or extra-cystic papillary excrescences, which may break off and give rise to peritoneal implants. It is more commonly of the pseudomucinous type. Papillary cystadenoma is of low grade malignancy and unless implants have already occurred, or the tumor is ruptured during the operation removal of the cyst nearly always results in permanent cure although the presence of papillomatous growth on the outside of the cyst makes the prognosis less favorable. In 35 per cent of the cases the tumors are bilateral. Twisting of the pedicle of such a cyst is frequent and results in the damming up of the venous blood, necrosis of the wall the loss of blood into the peritoneal cavity and ultimately peritonitis. With the growth of secondary peritoneal implants, ascites develops.

Papillary Cystofibroma This is the only ovarian papillary tumor that is always benign. In unilocular or multilocular cysts which resemble those previously described, firm white mural warts develop either within or outside the cyst. These growths differ however from the papillary cystadenoma in that they do not produce implants.

Dermoid This tumor which usually occurs in one ovary is a whitish sometimes rather thick walled cyst that contains caseous matter and often hair or other ectodermic derivatives.

Adenocarcinoma Carcinoma of the ovary may be present in association with large cysts in which case malignant nodules are seen within or outside of the cyst wall. In about 40 per cent of these cases the tumor is bilateral.

Solid Tumors

Adenocarcinoma This tumor which has already been mentioned under cystic tumors, may occur in the solid form and is bilateral in about 40 per cent of the cases The tumor is encapsulated at first but soon becomes adherent to the neighboring bowel and commonly causes metastasis to the omentum and elsewhere

Fibroma This tumor is unilateral in 90 per cent of the cases, and is an encapsulated and very firm white neoplasm which occasionally may have small cysts in its substance. The tumor is benign except that in about 1 per cent of cases fibrosarcoma may develop In the presence of a fibroma of fairly large size, ascites develops in some cases and occasionally also hydrothorax (Syndrome of Meigs)

Krukenberg Tumor This is a peculiar type of secondary carcinoma, which appears, often in both ovaries, usually in association with carcinoma of the stomach or some part of the gastro-intestinal tract. Ascites may or may not be present but the ovarian tumors probably develop as a result of the passage of malignant cells from the primary tumor into the peritoneal cavity and thence to the ovary A Krukenberg tumor may reach considerable size but characteristically the normal contour of the ovary is preserved.

Sarcoma. This malignant tumor may grow in one ovary or in both. It is more or less encapsulated, and on section the tumor is soft and friable.

Teratoma This tumor may occur in cystic or solid form, and occasionally is bilateral. It is usually malignant and, on section a variety of tissues can often be identified.

Granulosa-Cell Tumor This is an encapsulated, slowly growing solid tumor which on section has the appearance of liverwurst. Associated with the tumor there is enlargement of the uterus and the endometrium tends to be cystic and polypoid. The tumor is of low malignancy or benign. It secretes estrogen sometimes in sufficient amounts to induce uterine bleeding in elderly women, and precocious puberty in children. Bilateral tumors are frequent.

Theca-Cell Tumor This is a very rare tumor which produces a firm, yellowish, solid encapsulated mass in one ovary It also produces estrogen and is associated with enlargement of the uterus, hyperplastic endometrium, and uterine bleeding

Arrhenoblastoma This also is a very rare tumor which appears as a unilateral encapsulated solid mass and is sometimes malignant. In some

cases the tumor contains cells that produce the male sex hormone, and amenorrhea and reduction in size of the breasts may result.

Brenner Tumor This tumor may be solid or have the appearance of a cystadenoma. The solid tumors are encapsulated, smooth or nodular and are yellowish on cross-section. A cystic form appears as a pseudomucinous cystadenoma, with one or more nodules containing the Brenner tumor.

Dysgerminoma This is a solid encapsulated tumor which is often bilateral and which on section is brainlike in consistency. Necrotic and hemorrhagic areas are often seen. The tumor grows rapidly and is very malignant.

Mesonephroma Originating from the mesonephros, this is a solid or cystic growth, which is at first encapsulated but which may become disseminated. Microscopically, rudimentary glomeruli may be seen.

TREATMENT

The Uterus

Bicornate and Duplex Uterus These anomalies are not amenable to surgical treatment, nor do they as a rule produce symptoms. Pregnancy that develops in a uterine horn may cause signs and symptoms similar to tubal pregnancy and should be treated as would a pregnancy in the interstitial portion of the tube.

Injuries If the surgeon should accidentally perforate the uterine wall while doing a curettage instrumentation should be stopped immediately regardless of whether or not the procedure has been completed. Abdominal exploration should be undertaken only when the bowel is known to be perforated. In patients with perforation of the uterus caused by a criminal abortion, and in which spreading peritonitis is present medical treatment is the rule except in the rare instances when the patient is seen immediately after the abortion before infection has had an opportunity to develop. In these cases abdominal exploration may be advisable. A small tear of the uterus can be sutured, but in cases of severe lacerations, hysterectomy may be easier and safer to perform. The small bowel should be carefully examined at the same time and the colon particularly the sigmoid, should be inspected for perforations and any openings found should be closed. If a segment of bowel has been entirely cut off the two ends of the bowel should be sutured together after removing as much of the intestine as may be required to provide undamaged mesentery and blood supply.

Incomplete Abortion Dilatation and curettage is only rarely indicated to remove infective material from the uterine cavity since there is so much danger that the procedure may activate and spread the infection. In occasional cases, however the operation may be necessary to control

hemorrhage that threatens the life of the patient The curettement must of course, be performed with the greatest of care, because not only is the uterine wall softened by the recent pregnancy but infection has made the tissue still more friable. For the control of hemorrhage, the uterine cavity is firmly packed with a single strip of gauze about 2 cm. wide and long enough to fill the uterine cavity This gauze may be medicated with iodoform or treated with sulfanilamide or an antiseptic.

Lacerations of the Cervix Tears of the cervical segment that occur during labor should be repaired immediately after the delivery of the placenta, using interrupted sutures of chromic catgut and inserting all of the sutures before any are tied. Healed lacerations that are the cause of ulceration and leukorrhea should be treated by some type of plastic operation on the cervix. A laceration of the anterior lip may many times be treated by simply removing a V shaped segment including the laceration and suturing the cut surfaces together by two layers of interrupted sutures. Multiple lacerations, or lacerations of the posterior lip which have resulted in cervical erosions that cannot be handled by simple cauterization, necessitate amputation of the cervix after the child bearing age.

Rupture of the Uterus Laparotomy should be performed and the child, if viable or in the abdominal cavity should be removed, and either the tear in the uterus sutured in three layers or a hysterectomy performed. In many cases, because of the extensive and irregular character of the rent in the uterine wall and the hemorrhagic infiltration of the uterus, secure suturing may be impossible. When the child is not viable and is in the uterine cavity if the opening in the uterus can be sutured the child should first be removed, but if a hysterectomy is necessary it may be left in the uterus. Hysterectomy in any case may be total or subtotal, depending on the nature and location of the tear and the ease of the cervical dissection.

Displacements of the Uterus

Retroversion and Retroflexion Intra abdominal operations for the correction of these conditions have been almost universally adopted because of the opportunity afforded to examine the pelvic organs at the same time. Retrodisplacement of the uterus is so common that the symptoms of the patient should be carefully evaluated before deciding an operation is necessary but if retrodisplacement is incidentally found in the course of an operation for lower abdominal disease, the position of the uterus can in most cases be corrected without materially increasing the risk. The Baldy Webster method of shortening the round ligaments, combined with suturing together of the uterosacral ligaments and with or without advancement of the bladder on the uterus, can be recommended for general use.

Prolapse and Procidentia The most satisfactory treatment for these conditions is hysterectomy by the vaginal route, but operation on moderate degrees of prolapse may be postponed until the termination of the child bearing period. Coexisting cystocele and relaxed perineum should be corrected routinely at the conclusion of the hysterectomy The presence of moderate sized fibromyomata is not necessarily a contra indication to the vaginal route, but if other pathologic conditions are present in the pelvis, an abdominal operation with proper treatment of the complicating condition and hysterectomy is preferable the perineal floor and cystocele being repaired at the conclusion of the abdominal operation.

Inflammation

Acute Endometritis Surgical intervention is contra indicated in this condition unless a pelvic abscess forms and must be drained

Chronic Tuberculous Endometritis If X ray treatment, general tuberculous measures, and ultraviolet therapy have failed, chronic tuberculosis of the endometrium should be treated by abdominal hysterectomy If the Fallopian tubes and ovaries are involved, as is so often the case they should also be removed.

Cervicitis Inflammatory erosions of the cervix should be treated by cauterization, but if there is any question about the nature of a lesion, a section of the cervix should be removed for microscopic examination before the cauterization is done. For severe erosions, particularly when associated with laceration amputation of the cervix may be indicated if the patient is not in the child bearing age. The retention cysts of the cervical glands, which so commonly accompany cervicitis, should be treated by puncturing them with the cautery

Benign Tumors of the Uterus

Fibromyoma The usual treatment for fibromyomata of the uterus is abdominal hysterectomy a total hysterectomy being performed in most cases and always when the cervix is diseased or when the tumors are located low down in the cervical segment. Small fibromyomata causing no symptoms may be left alone especially when they are of the subserous type. In young women with a few small tumors myomectomy may be done with reasonable assurance that they can go safely through a subsequent pregnancy but it is impossible to be sure that one is getting all the tumors, and hysterectomy or radium therapy may be necessary later Myomectomy during pregnancy carries a high fetal mortality and should not be done unless the location and size of the tumors make it necessary The presence of fibromyomata extending from the lower uterine segment between the folds of the broad ligament often presents a difficult surgical problem. The dissection should be carried out with the position of the ureters always in mind, and sometimes it is even better to dissect out the

ureters and draw them aside before cutting off the uterus. A pedunculated fibroid protruding from the cervical canal should be removed by cutting its pedicle with scissors or a snare dilating the canal if necessary

Vaginal hysterectomy may sometimes be advisable for fibromyomata in elderly women particularly when the tumors are of moderate size and there is associated prolapse of the uterus. When difficulty arises in delivering the uterus and tumors by this route I have used obstetrical forceps to pull the mass out but in such cases it is better after cutting off the blood supply to bisect the uterus longitudinally and deliver each half separately

Adenomyoma The treatment of this type of tumor is the same as that described for fibromyoma.

Malignant Tumors of the Uterus

Carcinoma of the Cervix The usual treatment for carcinoma of the cervix is radium therapy A specimen of the lesion is removed, microscopic examination of the frozen section is made immediately and, if it shows carcinoma, radium is inserted and X ray therapy is given over the lower abdomen. When a large cauliflower like growth is present on the cervix, removal of a portion of the growth with the surgical diathermy is advisable. If stenosis of the cervical canal has occurred, dilatation of the canal to permit drainage of the uterine cavity is advisable. Radical hysterectomy of the Wertheim type instead of radium is advocated by some surgeons when the cervix and uterus are not fixed and no infiltration can be detected in the broad ligament.

Carcinoma of the Body of the Uterus Total abdominal hysterectomy with bilateral salpingo-oophorectomy should be performed if possible and should be followed by X ray therapy In some cases, extension of the growth to the bladder or rectum may make hysterectomy hazardous but in the case of the bladder if there is no extensive infiltration of its wall, a segment may be excised along with the uterus and the cystotomy closed by two layers of inverting sutures. If exploration reveals extensive metastasis to the retroperitoneal glands or if peritoneal implants are seen anything more than palliative therapy is contra indicated, but when the disease is inoperable but confined to the region of the uterus, intra-uterine radium may be of value. When a portion of small bowel is adherent to a malignant tumor of the uterus, unless the adhesion is due to infiltration by the carcinoma, the bowel should be easily separable from the uterus, and the wall of the bowel after it has been separated, should not feel thickened. If the malignancy has extended to the bowel the involved segment should be resected with a liberal margin of normal tissue on each side of it, and the intestinal continuity should be re-established by end-to-end anastomosis. This same principle holds true when the large bowel is the portion involved, except that when the lower sigmoid is invaded the

operation becomes much more difficult and the likelihood of accomplishing a permanent cure is lessened.

Sarcoma of the Uterus The treatment of this condition is the same as that for carcinoma of the body of the uterus.

Chorionepithelioma This should be treated by total abdominal hysterectomy and bilateral salpingo-oophorectomy and the upper segment of the vagina should also be included because of the tendency of the tumor to metastasize to the vaginal wall. If the malignant character of the tumor is in doubt, careful curettage of the uterine cavity and examination of the specimens removed should be done The Ascheim Zondek test is of diagnostic value and should be performed at monthly intervals for some time after a patient has passed a hydatid mole.

Polyps These tumors should be removed by excision when they are in the cervical canal, and by curettage when they are present in the uterine cavity

Placental Rests Dilatation and curettage are necessary because of persistent bleeding

Hydatiform Mole This tumor is passed spontaneously, but the patient should be kept under observation for a long period afterward, and abnormal uterine bleeding should be an indication for dilatation and curettage to be sure that a chorionepithelioma has not appeared in the uterus. The development of a strongly positive Ascheim Zondek test is confirmatory evidence of the tumor

The Fallopian Tube

Congenital Abnormalities Inflation of the tube with air by means of a Luer syringe may reveal constrictions or bands that can be corrected. Cysts which have developed from the Wolffian ducts or Wolffian body should be removed when found, although they are usually so small as to cause no symptoms.

Inflammation Acute inflammatory disease of the Fallopian tube is not a surgical condition. The tubes should not be removed even though the abdomen has been opened, unless the patient is past the child-bearing age. If chronic salpingitis is present particularly with pyosalpinx or hydrosalpinx, salpingectomy should usually be performed and the operation should include oophorectomy when a tubo-ovarian abscess exists. When the patient is anxious to have children, tubes that are chronically diseased may be left in, in the hope that penicillin therapy and control of reinfection will bring about cure of the disease. In some of these cases, one tube may show much more advanced and obstructive disease than the other and one may choose to leave it in. If the ovary is involved, it should be removed but one ovary should be left in if possible. Extensive resection of the remaining ovary is less desirable however than bilateral oophorectomy If both ovaries and tubes must be taken out, a total hysterectomy

should also be performed. Operation in chronic salpingitis should be avoided during an acute exacerbation of the disease, but it may be necessary to make an exception of this rule in order to drain a pelvic abscess. If such an abscess points into the posterior cul-de-sac, and given enough time most such abscesses do it should be drained by the vaginal route. An incision is made through the vaginal wall at the area of greatest fluctuation, and a hemostat is introduced into the abscess cavity and opened. In some cases it may be necessary to drain the abscess by an abdominal incision, and not infrequently an abscess will be encountered unexpectedly in the performance of a salpingectomy Removal of chronically inflamed tubes may be an exceedingly difficult operation and drainage of the secondary abscess may offer the best way out of a dangerous dissection that might end in the accidental tearing of adherent bowel. After the pus has been evacuated and drains inserted, a subsequent operation may be performed if necessary with a great deal more ease and safety

Tuberculous salpingitis in which conservative therapeutic measures have failed should be treated by bilateral salpingo-oophorectomy and hysterectomy but the patient should be afrebile no cystitis should be present, and the disease should be localized in the uterus and adnexa. If the condition is encountered at operation it may not be recognized. If it is, the decision whether or not to remove the pelvic organs must be individualized.

Perisalpingitis and salpingitis of non gonorrheal origin should not be subjected to operative treatment, and if such lesions should be unexpectedly encountered with the abdomen opened, the tubes should not be removed unless pyosalpinx is present, or unless it is necessary to remove the uterus to eliminate the source of infection.

Ectopic Pregnancy The abdomen should be opened through the usual midline incision and the involved organ, usually the tube should be removed. Unless the ovary is the site of the pregnancy it can frequently be spared. If the tube has ruptured and large clots of blood are found in the pelvis, they may be removed, but no attempt should be made to aspirate all the blood from the abdominal cavity since it will be absorbed with benefit to the patient. No other operation, such as appendectomy should be done, because of the danger of infecting the intraperitoneal blood and causing peritonitis.

If one should happen to encounter an abdominal pregnancy after removing the fetus the placenta should be removed from its point of attachment if possible If it appears to be dangerous to do this the cord may be cut and the placenta left *in situ*

Tumors Any tumor found in the Fallopian tube should be treated by salpingectomy on the affected side. If the tumor proves to be a carcinoma, bilateral salpingo-oophorectomy and total abdominal hysterectomy should be performed.

The Ovary

Inflammation Acute inflammation may involve the surface of the ovary as an extension from an inflammatory process elsewhere and will subside when the infection is treated at its source. The acute oophoritis of gonorrhea requires no surgical treatment unless an abscess of the ovary has formed, when removal of the ovary and tube is usually indicated.

Tuberculosis of the ovary is usually associated with tuberculosis of the Fallopian tube and uterus (see Tuberculous Salpingitis page 484)

Simple Cysts Multiple small simple cysts of the ovary occurring in a young woman require no treatment and have a tendency to disappear spontaneously When a cyst reaches a diameter of 2 cm. or more, however it may cause pain, and removal of the portion of the ovary containing the cyst should be done if the condition is discovered at operation. Whether operation should be done primarily to remove such a cyst depends solely on the amount of discomfort produced, since a cyst of this nature leads to no dangerous complications.

Inflammatory Cysts of the Peritoneum These cysts require no treatment, but may be ruptured or wiped off the peritoneal surface.

Endometrial Cysts and Endometriosis An endometrial cyst of the ovary should be resected and, if it is large it may be necessary to remove the entire ovary If both ovaries are involved, an attempt should be made to save a portion of one ovary but if necessary both the glands should be sacrificed. In the young childless woman, conservatism should be carried to the extent of postponing sterilization even at the expense of continued symptoms and reoperation at a later time. In other cases, small blueberry or raspberry-colored nodules occasionally seen on the uterus, ovaries, or tubes are not disturbed, but if such lesions are extensive, or if there are tarry cysts of both ovaries which cannot be dissected out, bilateral salpingo-oophorectomy and total abdominal hysterectomy should be done. Large endometrial growths present on the bowel should be removed if possible but if this is difficult or dangerous bilateral oophorectomy and hysterectomy should be performed and the growths left undisturbed, since removal of the ovaries will cause gradual shrinkage of the tumors.

Tumors All ovarian tumors should be treated by oophorectomy It should be remembered, however that the Krukenberg tumor is a secondary carcinomatous growth, and its removal is of no avail unless the primary tumor is also removed. Even then the operation is only of a palliative nature. In dealing with cystic tumors, the abdominal cavity should be well packed off before the tumor is mobilized to prevent dissemination of the fluid contents in case the cyst is accidentally ruptured. Cystic tumors of the ovary even if they are very large should be removed *en masse* without any attempting to draw off the fluid by means of a trochar In some of these cases a very long abdominal incision [illegible] but

there is less danger of spilling fluid, which in the case of papillary tu mors may cause implants on the peritoneal surface and in any case many of the cysts are multilocular and cannot be emptied by puncture If tumors are present in both ovaries, bilateral oophorectomy should be performed, but in the case of carcinoma and sarcoma, not only should both ovaries be removed but the uterus must also be sacrificed. In fact in any case where bilateral oophorectomy is indicated, it is well to remove the uterus at the same time, since it would remain as a useless organ which might give trouble later In dealing with disgerminoma, even though only one ovary is apparently involved, bilateral oophorectomy should be done. This is true also in papillary cystadenoma except that in the case of a woman who wishes children, the affected ovary only may be removed and the patient kept under observation. X ray treatment should follow the operation on carcinoma, papillary cystadenoma tera toma, and disgerminoma. If at operation a papillary cystadenoma is found to have ruptured and produced abdominal metastases, the primary tumor should be removed as thoroughly as can be done and as much as possible of the metastatic tumor tissue and fluid should be scooped out. In the extensive dissection so often entailed, the ureters should be located and carefully avoided. If postoperative radiation is given in such cases, the patient may remain well for a number of years and at the end of that time operation may again be performed with similar treatment of the metastatic growths that have developed.

TECHNIQUE

Suspension of the Uterus (Baldy-Webster Method)

The fundus of the uterus is held up by a tenaculum, and an Allis for ceps is applied to one tube near its end, so that the tube can be elevated. A hemostat, pushed through the broad ligament from back to front just below the ovarian ligament (Figure 169) is used to grasp the round ligament about 4 cm. from the uterus and the round ligament is pulled through the rent in the broad ligament (Figure 170) A similar procedure is done on the opposite side and then while the round ligaments are approximated by tension on the hemostats, they are sutured together and to the posterior surface of the uterine wall (Figure 171) If the liga ments cannot be approximated, they may be sutured independently to the posterior surface of the uterus Combined with this operation it is advisable to shorten the uterosacral ligaments by placing a few inter rupted sutures in them and bringing them together until the relaxation in the broad ligaments is corrected.

If desired, the uterovesicle peritoneum may be advanced on the uterus by incising the peritoneum transversely just above the region of bladder reflection (Figure 172) freeing the peritoneum and bladder downward

FIG. 169 *Baldy-Webster Suspension.* A hemostat is being pushed through the broad ligament under the round ligament.



FIG. 170 *Baldy-Webster Suspension.* A hemostat has grasped the round ligament and is pulling it through the broad ligament.

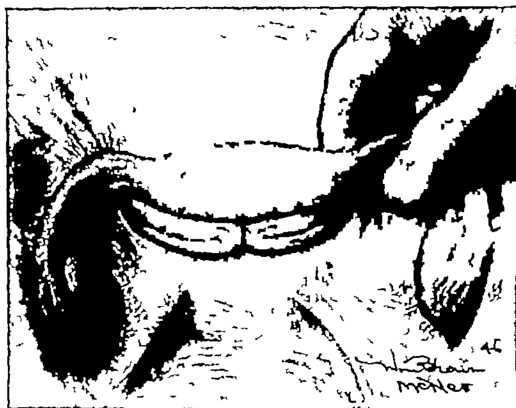


FIG. 171. *Baldy-Webster Suspension.* The round ligaments are fastened together and to the posterior surface of the uterus.

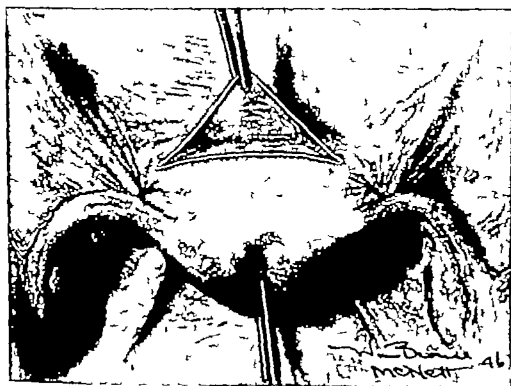


FIG. 172. *Advancement of the Bladder.* An incision has been made in the peritoneum just above the bladder reflection and the bladder has been separated from the anterior surface of the uterus.



Fig. 169 *Baldy-Webster Suspension.* A hemostat is being pushed through the broad ligament under the round ligament.



Fig. 170 *Baldy-Webster Suspension* A hemostat has grasped the round ligament and is pulling it through the broad ligament.

Fig. 171 *Baldy-Webster Suspension.* The round ligaments are fastened together and to the posterior surface of the uterus.

Fig. 172 *Advancement of the Bladder.* An incision has been made in the peritoneum just above the bladder reflection and the bladder has been separated from the anterior surface of the uterus.

by blunt dissection, and then re-anchoring the peritoneum higher on th uterus with a few catgut sutures (Figure 173)



FIG. 173 *Advancement of the Bladder* The peritoneum is pulled up and sutured to the anterior surface of the uterus at a higher level

Myomectomy

The fundus of the uterus is grasped with a tenaculum to steady it, and an incision is made through the uterine wall down to the fibroid. The



FIG 174 *Myomectomy* A Dotted line indicates incision over myoma. B The tumor is being enucleated with a hook.

tumor is grasped by a forceps or hooked with a sharp instrument and pulled out of its bed (Figure 174) The cavity left behind is closed by interrupted sutures of catgut in the uterine wall.

Cesarean Section

An incision is made in the midline between the umbilicus and symphysis. In opening the peritoneum extreme care should be used to avoid the bladder since it is commonly displaced upward A moist gauze pack is put in on each side of the uterus to protect the peritoneal cavity and a short incision is made through the uterine wall in the midline Two fingers

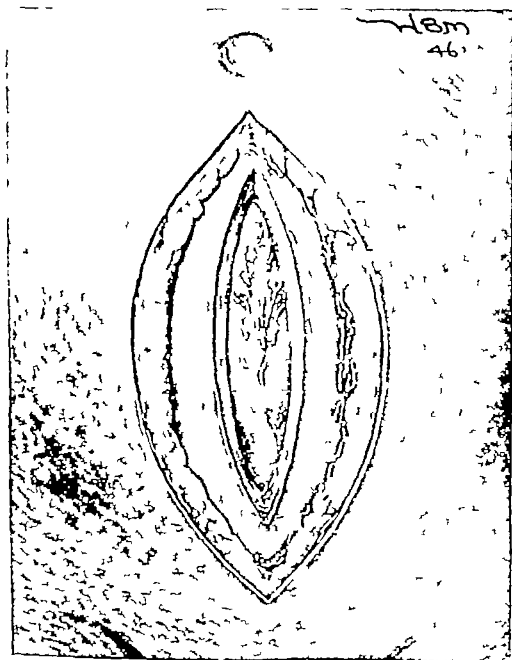


Fig 175 Cesarean Section. The abdomen has been opened by an incision between the umbilicus and the symphysis The incision has been deepened through the anterior wall of the uterus, exposing the membranes

are inserted into the uterus through this incision, and, with the f
lifting up the uterine wall the incision is rapidly lengthened to
12 cm. (Figure 175) The membranes are ruptured and the left h



FIG. 176 *Cesarean Section* The child has been delivered from the uter
the uterus has been brought out on the abdominal wall The placenta i
in place

inserted into the uterine cavity where a foot is located, and u
extract the child. The uterus is quickly delivered out of the ab
(Figure 176) and the assistant grasps it firmly with his hand ar
near the cervix, so that the bleeding can be controlled until the ute
contracted. The cord is doubly clamped and tied by the usual m
and the placenta, which readily loosens is extracted, care being t
remove all of the membrane. One cubic centimeter of pituitrin is in

into the uterine wall, and the uterine incision is closed by three layers of catgut sutures (Figure 177) The packs are removed and any fluid present in the abdomen is removed by suction. The operation just de-

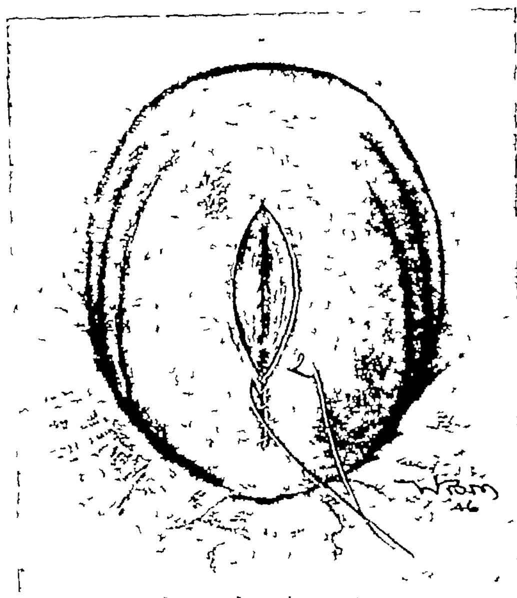


FIG. 177 *Cesarean Section*. The incision in the uterus is being closed. Two or three layers of catgut sutures are used

scribed is the conservative cesarean section, and is the method most generally used, although many obstetricians prefer the "low" cesarean and the extraperitoneal route.

Subtotal Abdominal Hysterectomy

The fundus of the uterus is grasped with a tenaculum or towel forceps and pulled up into the wound. If large fibromyomata are present, the

delivery of the uterus and tumors out onto the abdominal wall aids materially in providing working space in the pelvis. With scissors, the peritoneum is incised transversely on the anterior surface of the uterus above the line of bladder reflection. This incision is extended outward and slightly upward through the anterior layer of the broad ligament on each side for a distance of about 5 cm. from the midline. By gauze stripping,

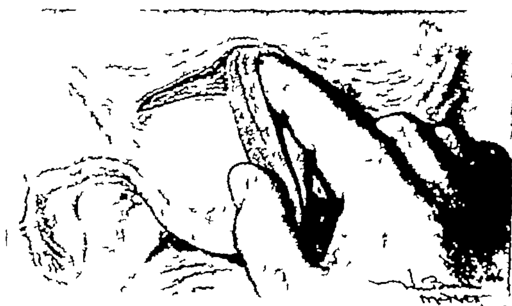


FIG. 178. *Abdominal Hysterectomy* An incision has been made through the peritoneum on the anterior aspect of the broad ligaments and in front of the uterus just above the bladder reflection The bladder is being stripped down from the anterior surface of the uterus.

the peritoneum and bladder are now pushed down off the cervical segment (Figure 178) Little resistance to this stripping is encountered on each side, but near the midline the tissues are more adherent and a few snips with the scissors may be required. The left index finger is inserted into the opening already made in the anterior layer of the broad ligament and is pushed through the posterior layer The space between the edge of the uterus and the round ligament is avascular if care is taken to avoid the uterine artery which lies near the uterus. The bent finger now lifts up the round ligament and Fallopian tube (Figure 179) and these structures are doubly clamped near the uterus With the use of scissors, the tissue between the clamps is cut, the fundus of the uterus is pulled laterally and a few snips of the scissors will separate the areolar tissue down to the region of the uterine artery The cervix is palpated and, since in a subtotal hysterectomy the uterus should be cut off at the level of the internal os, the uterine artery is doubly clamped at this level. For this purpose it is advisable to use fairly heavy clamps, and the curved style is more easily applied. The clamps should be put on at right angles to

the cervix and to be sure of getting the uterine artery which lies close to the cervix, the clamps should be allowed to slide off the edge of the cervix onto the vessel. The artery is cut between the clamps and a little tension is made on the lower clamp in order to pull the artery slightly

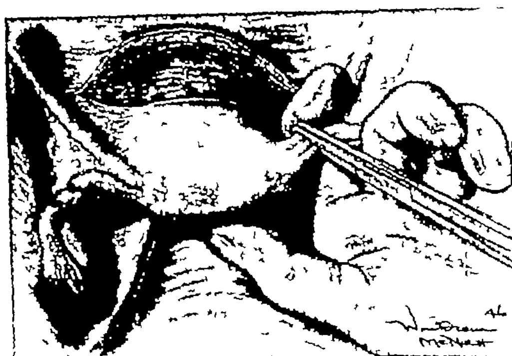


FIG 179 *Abdominal Hysterectomy* A finger has been passed through the posterior layer of the broad ligament and up into the lateral angle of the anterior peritoneal incision. The round ligament and tube are lifted up by the finger and doubly clamped.

away from the cervix so that it can be more easily tied. The fundus of the uterus is now swung over to the other side, and the tube and round ligament and uterine artery are similarly dealt with. The fundus is swung back and the cervix is cut off with scissors, leaving a slightly concave surface in the stump. Before the incision is completed, the anterior lip of the cervix is grasped with a tenaculum or Ochsner hemostat so that it can be held up for suturing Using #0 chromic catgut on a curved cutting needle, the cervical stump is closed by two layers of sutures, and the end of the suture, after being tied, is left long for traction. The clamp on the right round ligament and tube is now held up and the structures are ligated, using a transfixion ligature the clamp being slowly removed as the ligature is tightened. The right uterine artery is now tied, and the left tube and round ligament and uterine artery are similarly dealt with. A suture is passed through the round ligament just below the point where it was ligated and then into the lateral edge of the cervical stump. As this suture is tied, the round ligament is brought down to the cervix. The anterior and posterior lips of peritoneum are caught by the next bite of

this suture, in such a way as to cover the stump of the round ligament and tube. The suture is continued across the cervix until the other side of the cervix is reached, at which point the needle penetrates the cervix, then passes up through the left round ligament, so that it can be pulled down to the cervix and covered with peritoneum as the suture continues.



FIG 180. *Abdominal Hysterectomy* On the other side a finger is similarly passed through the broad ligament and lifts up the round and ovarian ligaments On this side the tube and ovary are to be removed. The round and ovarian ligaments are doubly clamped.

When it is desired to remove the tube and ovary in addition to the uterus the procedure is practically the same except that the clamp instead of being applied to the round ligament and tube, is applied to the round ligament and ovarian vessels just lateral to the ovary (Figure 180)

Total Abdominal Hysterectomy

This procedure differs from subtotal abdominal hysterectomy only in that the cervix is removed. After the uterine vessels have been clamped (Figure 181) and cut, two additional clamps may be used. These should be curved, and one is applied to each side of and parallel to the cervix, with the tip extending onto the upper vaginal wall. Curved scissors are used to snip the tissue close to the cervix until it is free. The bite of the scissors should always be directed at the cervix itself and extreme care should be taken to avoid injury to the ureter bladder and rectum. When the dissection has extended down to the level of the external os, as determined by palpation, an incision is made in the anterior vaginal wall and the anterior lip of the vagina is caught with a hemostat (Figure 182) The

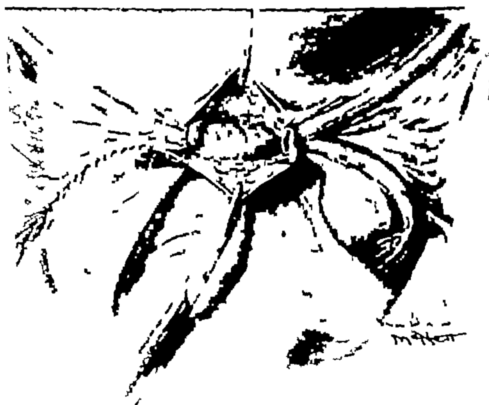


Fig. 181 *Abdominal Hysterectomy* The uterine artery is doubly clamped.

Fig. 182. *Total Abdominal Hysterectomy* The vaginal wall has been cut through below the cervix, and as the incision is being made, the upper end of the vagina is grasped with hemostats.



Fig 183 *Total Abdominal Hysterectomy* The vagina is closed by two layers sutures On the left the round and ovarian ligaments have been tied, and the right the tube and round ligament have been ligated.



184 *Total Abdominal Hysterectomy* The ligaments have been anchored top of the vagina and the peritoneum is being closed over the stumps of nts and vagina

incision is then continued around until the vagina has been cut off just below the cervix. The posterior lip of the vagina is caught with another hemostat, and the open end of the vagina is closed by two layers of chromic catgut (Figure 183), one end of the suture being left long for traction. The round ligaments are brought down and the surface is peritonealized as described under subtotal abdominal hysterectomy (Figure 184)

Wertheim's Panhysterectomy

The round ligament and ovarian vessels are doubly clamped and ligated as close to the brim of the pelvis as possible. Starting in the right avascular space, the anterior and posterior layers of the broad ligament are now separated by blunt dissection down to the base of the ligament. The ureter which adheres to the posterior leaflet slightly lateral to and above the uterosacral ligament, is located by palpation isolated, a tape is passed under it, and it is drawn aside. A similar procedure is carried out on the opposite side, and the incision through the vesicle reflection of peritoneum is continued across the midline. A finger is pushed through the base of the broad ligament near the ureter and the uterine vessels are lifted up so that they can be clamped and ligated as near the pelvic wall as possible. After the uterine vessels of the opposite side have been ligated, the uterosacral ligaments are cut about 1 cm. away from the uterus, and the incision in the posterior layer of the broad ligament is continued down and over to the opposite side. The bladder is pushed forward and, always keeping the position of the ureters in mind, dissection through the cellular tissue is continued down below the cervix so that a cuff of vagina can be excised. At the point chosen for section, the anterior vaginal wall is opened, the lower lip grasped with a hemostat, and the incision continued around the vagina with scissors. The vaginal vault is closed by two layers of sutures, and any enlarged glands found in the pelvis are dissected out. The operation is completed by suturing together the anterior and posterior peritoneal margins so that all raw surfaces are covered.

Vaginal Hysterectomy

With the patient in the lithotomy position a weighted retractor is inserted into the vagina and the cervix is grasped by a tenaculum in such a way as to occlude the cervical canal. With the use of a knife an incision is made which encircles the cervix and then extends along the anterior vaginal wall almost to the urethral opening (Figure 185) The edges of the vaginal incision are grasped with hemostats, and by the combined use of gauze stripping and sharp dissection, the vaginal walls are stripped aside and the bladder is separated from the uterus so that it can be pushed high up. A Deaver retractor is used to hold the bladder out of the way while an incision is made through the vesico-uterine peritoneal reflection



Fig. 185 *Vaginal Hysterectomy* An incision has been made around the cervix and extended upward almost to the urethra.

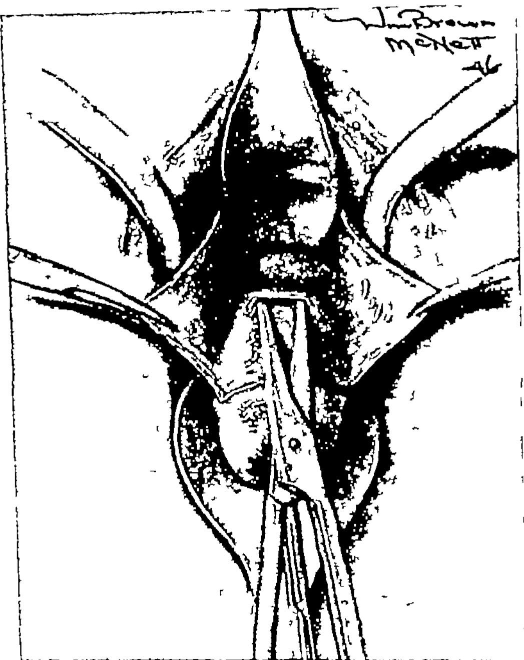


Fig. 186 *Vaginal Hysterectomy* Vaginal flaps have been dissected laterally from the cervix and an opening is made through the peritoneum between the bladder and the uterus.



FIG 187 *Vaginal Hysterectomy* The peritoneal opening having been enlarged, the fundus of the uterus is grasped and pulled outward.

into the peritoneal cavity (Figure 186) This opening is enlarged until the fundus of the uterus can be delivered down through it (Figure 187) A finger is passed around the tube and round ligament on one side, and

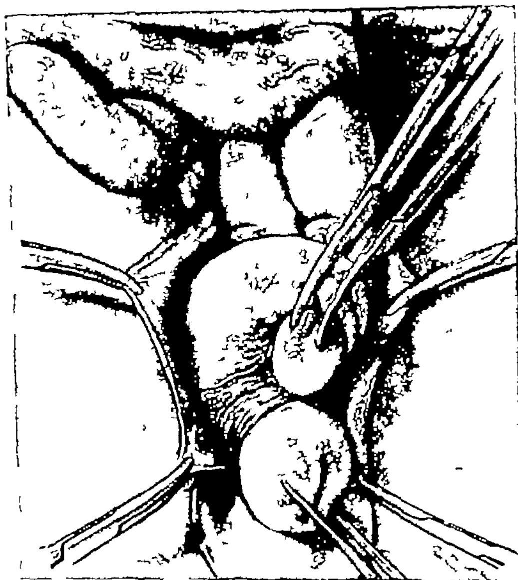


FIG. 188 *Vaginal Hysterectomy* A finger passed around the round ligament and tube holds them up while they are doubly clamped.

pushed through the avascular space in the broad ligament. Two heavy clamps are applied to the tube and round ligament, and the tissue is cut between them (Figure 188) A similar procedure is then executed on the other side. If difficulty is experienced in delivering the fundus of the uterus, it helps in many cases to replace the cervix back into the vaginal vault before traction is made. The vaginal mucosa is dissected from the posterior surface of the uterus, beginning at the incision that encircles the cervix, and the mucosa is dissected upward until the posterior cul-de-sac

can be opened, the latter procedure being facilitated by placing a hand over the fundus of the uterus into the cul-de-sac (Figure 189) Two heavy clamps are applied on each side of the uterus to the remaining tissue,

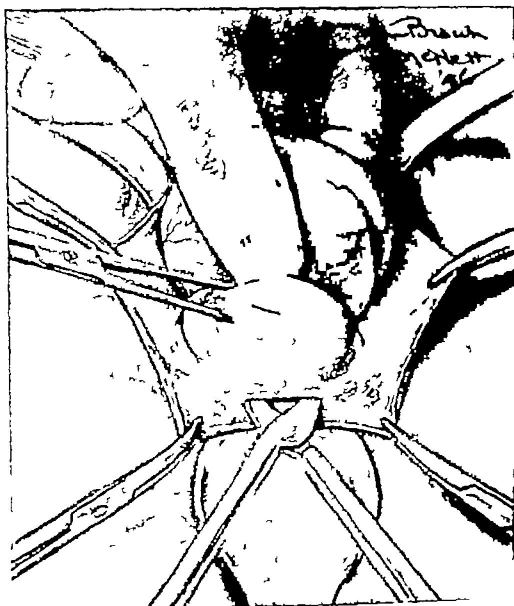


FIG. 189 *Vaginal Hysterectomy* With the aid of a finger behind the uterus, an opening is being made in the posterior cul-de-sac. In this drawing the round ligaments and tubes are not yet cut.

which contains the uterosacral ligaments and the uterine vessels (Figure 190) and the tissue is cut between them. The uterus is now freed, its blood supply has been controlled and it is removed. Suture ligatures are used to tie off the round ligament and tube on each side. After this has been done the two ligaments are tied together (Figure 191) the ligatures being left long. The uterine vessels are tied on each side and the clamps

are removed. The musculofascia of the anterior vaginal wall is sutured together and at the upper end, sutured also to the stumps of the round ligaments, using a continuous suture of fine chromic catgut. This is fol

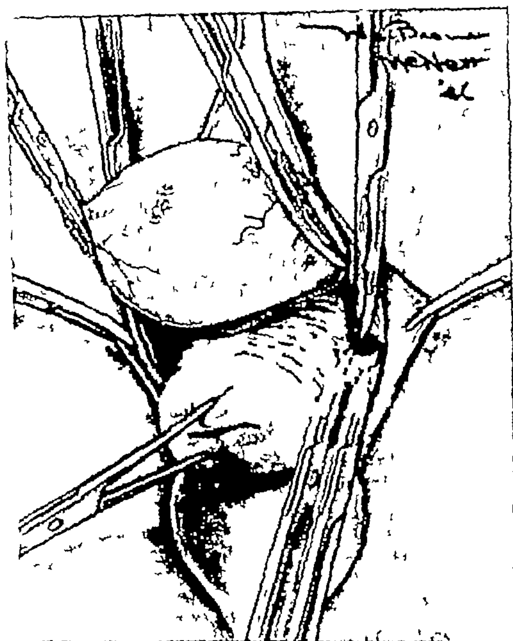


FIG. 190. *Vaginal Hysterectomy* The broad ligament has been doubly clamped and divided and clamps have been applied to the uterine artery

lowed by a continuous catgut suture to bring together the mucosa of the vaginal wall. In most cases there will be found to be excess vaginal tissue in the anterior wall, and before the suturing is done it should be cut off freely with scissors.

Variations of the procedures described above may sometimes be used

to advantage. Some prefer to open the posterior cul-de sac before inc the vesico-uterine peritoneum and in certain cases it may be easi ligate the uterine artery below on each side before the fundus of uterus is delivered.

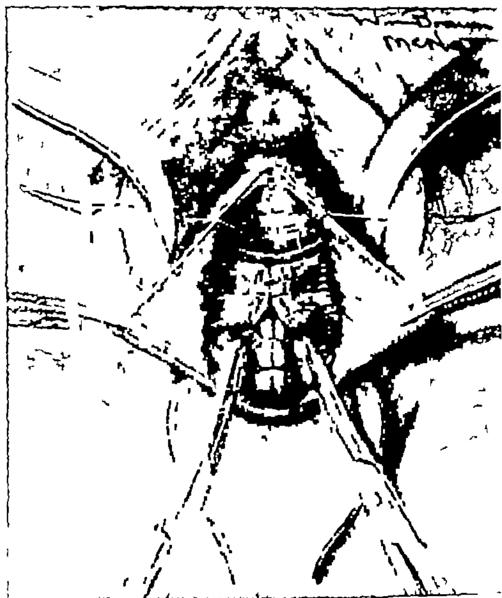


FIG. 191 *Vaginal Hysterectomy* The stumps of round ligaments and tub above and broad ligaments below have been sutured together Clamps still r main on the uterine artery which will be tied The anterior vaginal wall w then be closed by two layers of sutures, redundant tissue if present, being r moved

Salpingectomy

The fundus of the uterus is grasped by a tenaculum, and an Allis f ceps is applied to the Fallopian tube near its fimbriated end. The tube held up while a series of clamps are applied to the mesosalpinx near t

tube the tube being cut loose from the mesosalpinx as the clamping procedes until finally the tube itself is doubly clamped near the uterus. If it is desired to remove the interstitial portion of the tube an elliptical incision is made through the entire thickness of the uterine wall at the region of the tubal attachment and extending somewhat medially (Figure 192A and B) The clamps on the mesosalpinx are removed as the

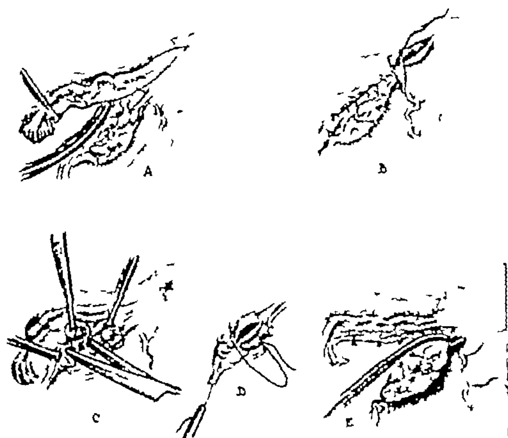


Fig. 192. *Salpingectomy and Oophorectomy* A and B. Salpingectomy C. Partial oophorectomy D Closure of the raw ovarian surface left by partial oophorectomy E Oophorectomy

tissue is ligated, and two or three mattress sutures are placed to close the incision in the uterine wall. If the interstitial portion of the tube is not to be removed, the tube that has been doubly clamped near the uterus is cut between the clamps. The stump attached to the uterus should be as short as possible and is ligated with chromic catgut as the clamp is removed. In most cases a suture ligature is more satisfactory In many cases when salpingectomy is indicated the tube is greatly enlarged, thickened and surrounded by adhesions and plastered down on the posterior surface of the uterus. Before the salpingectomy is attempted, the tube must be separated carefully by finger dissection from the surrounding structures.

Oophorectomy

If there is a large tumor of the ovary it should be freed by running the hand around it and separating any adhesions present. Then if possible the tumor is delivered out of the abdomen. In any case, the ovary or tumor is held up while the vessels in the infundibulopelvic ligament (ovarian artery and vein) and the ovarian ligament are doubly clamped and cut (Figure 192E) After the ovary has been removed, the clamped tissues are tied, and the raw surface is peritonealized.

Salpingo-Oophorectomy

The tube and ovary are held up by Allis forceps, the infundibulopelvic ligament is clamped and tied, and the ovarian ligament and tube are similarly dealt with. A few stitches are taken to close the layers of the broad ligament after the tube and ovary have been removed and to cover all the raw surface.

Partial Resection of the Ovary

The portion of the ovary to be resected is grasped with an Allis forceps and held up while a hemostat is clamped below it. After the hemostat is closed, the segment of ovary is cut off and a running suture is put in below the clamp (Figure 192C and D) The suture is not tied at either end, but after the clamp has been removed the two ends are tied together thus folding the resected surface on itself. In some cases a hemostat can not be closed on the ovary without cutting through the tissue. If so, it is better to apply an Allis forceps to each pole of the ovary as the tissue is cut off with scissors, the stump is closed with a running suture.

Dilatation and Curettage

With the patient in the lithotomy position, a weighted retractor is inserted into the vagina and the anterior lip of the cervix is grasped with a tenaculum and pulled outward. A uterine sound is introduced into the uterine cavity to determine its depth after which a uterine dilator is placed in the cervical canal and the canal is gently stretched enough so that a curette can be introduced. A gauze sponge is placed below the posterior lip of the cervix to catch the scrapings The curette is gently but firmly passed along the uterine wall often enough to make certain that every part of the inside of the uterus has been covered. Care must be used not to push too hard on the curette, but enough pressure must be made to remove the mucosa. In the normal uterus, there is a characteristic fibrous feel to the uterine wall after the mucosa has been taken off which assures the surgeon that the curetting has been complete. To control the bleeding, the uterine cavity is packed with gauze, either plain or medicated with iodoform or antiseptic.

Cauterization of the Cervix

The cervix is grasped with a tenaculum and pulled down, and the neighboring vaginal wall is protected by moist gauze sponges. The cau

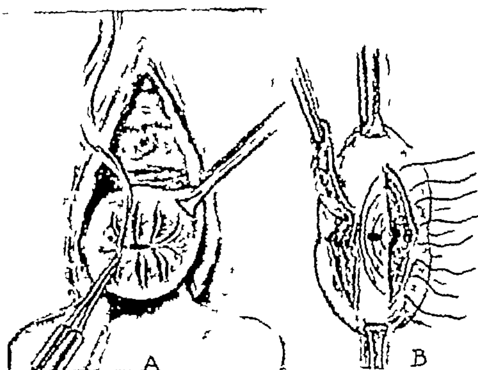


FIG 193. *Cauterization of the Cervix and Trachelorrhaphy* A. Cauterization A weighted vaginal speculum has been inserted, and while the cervix is held with a tenaculum, cauterization is performed in a radial manner B Trachelorrhaphy The upper and lower lips of the cervix are held by tenacula while strips of mucosa are removed on each side of the cervical canal. The raw surfaces are brought together by a series of interrupted sutures.

tery which should be heated to a cherry-red color is used to make radial cuts in the cervix about .5 cm. apart (Figure 193A) If cysts are present, they are punctured with the tip of the cautery

Removal of Cervical Polyp

The anterior lip of the cervix is pulled down and the polyp is grasped by an Allis forceps while it is cut off at its base by scissors or knife. The base of the polyp is then thoroughly curetted, and cauterized if desired.

Trachelorrhaphy

Tenacula are placed on the anterior and posterior lips of the cervix, and with a knife the mucosa is removed from the two lips to be approximated until only a strip about 1 cm. wide is left in the midline. The raw surfaces are approximated by interrupted sutures, all of which are introduced before any are tied (Figure 193B)

Amputation of the Cervix

A mobile cervix and good exposure are necessary in the performan of this operation. A weighted retractor is inserted into the vagina and t anterior and posterior lips of the cervix are grasped by tenacula A ho

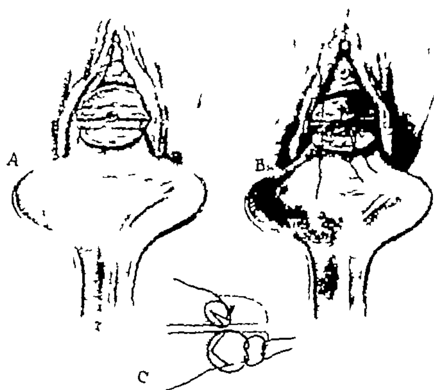


Fig 194 *Amputation of the Cervix.* A After a horizontal bisecting incision, th diseased portion of the cervix is removed, leaving a W-shaped stump. B The wedges are being closed after preliminary sutures that pass through the cervical canal C. Diagram of the method of amputation and closure. The sutures show are those which pass through the cervical canal.

zontal bisecting incision is made in the cervix and extended upward hig enough to be well beyond the area of infection. The diseased portion each lip of the cervix *is removed by* a wedge-shaped incision (Figu 194A) An interrupted suture of chromic catgut is introduced to approx mate the mucosa of the cervical canal to that of the upper portion of th cervix and a similar suture is put in below Deeply placed interrupte *silkworm sutures are now used to coapt the cut surfaces* (Figures 194 and C) thus closing the wedges and restoring the normal cervical con tour The silkworm sutures are left long and are not removed sooner tha two weeks postoperatively

POSTOPERATIVE CARE

In most cases after the patient has been returned to bed a liter of 5 per cent glucose in saline is given intravenously and this is repeated as necessary to keep up the liquid intake If there has been considerable loss of blood, or if the patient was anemic before operation, a transfusion of 500 cc. or more of blood is given. Liquids are permitted by mouth as soon as nausea has subsided, but if vomiting persists, continuous gastric suction is instituted and the tube is also used in the treatment of distention. Morphine is given for pain or restlessness, but after a few days barbitu rates can be substituted to assure rest at night. An intra-uterine pack should be removed in forty-eight hours. A perineal wound should receive special care in the form of external cleansing douches, and application of the heat lamp three times a day is helpful in preventing maceration of the tissues. If the patient does not void, the bladder should be emptied by catheter every eight hours, or oftener if there is distress. An enema is given on the third day and thereafter mineral oil or milk of magnesia is given as necessary to assure a daily bowel movement.

Amputation of the Cervix

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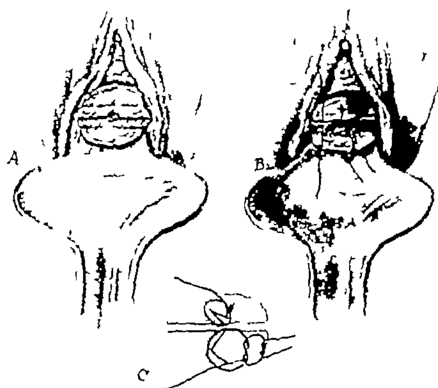


FIG. 194 *Amputation of the Cervix* A After a horizontal bisecting incision the diseased portion of the cervix is removed, leaving a W shaped stump. B The wedges are being closed after preliminary sutures that pass through the cervical canal C. *Diagram of the method of amputation and closure* The sutures shown are those which pass through the cervical canal.

zontal bisecting incision is made in the cervix and extended upward high enough to be well beyond the area of infection. The diseased portion of each lip of the cervix is removed by a wedge-shaped incision (Figure 194A) An interrupted suture of chromic catgut is introduced to approximate the mucosa of the cervical canal to that of the upper portion of the cervix, and a similar suture is put in below Deeply placed interrupted silkworm sutures are now used to coapt the cut surfaces (Figures 194B and C) thus closing the wedges and restoring the normal cervical contour The silkworm sutures are left long and are not removed sooner than two weeks postoperatively

POSTOPERATIVE CARE

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CHAPTER XXIII

The Female External Genital Organs, Perineum, and Vagina

PREOPERATIVE PREPARATION

LESIONS

- Congenital Abnormalities
- Cyst and Abscess of the Bartholin Gland
- Urethral Caruncle
- Urethrocele and Cystocele
- Rectocele
- Vesicovaginal Fistula
- Rectovaginal Fistula
- Tumors of the Vulva and Vagina

TREATMENT AND TECHNIQUE

- Congenital Abnormalities
- Cyst and Abscess of the Bartholin Gland
- Urethral Caruncle
- Urethrocele and Cystocele
- Technique of Anterior Colporrhaphy
- Watkins-Wertheim Transposition Operation
- Rectocele
- Posterior Colporrhaphy
- Vesicovaginal Fistula
- Rectovaginal Fistula
- Tumors of the Vulva and Vagina

POSTOPERATIVE CARE

The Female External Genital Organs, Perineum, and Vagina

PREOPERATIVE PREPARATION

The bowel should be emptied by an enema the night before operation, and on the morning of operation the bladder is catheterized. The perineum and abdomen are shaved, and in the operating room they are thoroughly cleaned with soap and water The vagina perineal region, upper part of the thigh and lower abdomen are painted with an antiseptic. If the antiseptic is irritating to the skin and all that use alcohol and acetone as a vehicle are, the liquid should not be allowed to collect on the Kelly pad under the buttocks or burns may result. General preoperative measures are the same as those mentioned in the chapter on The Uterus, Ovary and Fallopian Tube.

LESIONS

Congenital Abnormalities

The vagina may be entirely absent or represented by a small fibrous cord, and atresia of a portion of the vagina, in which usually the lower third is obliterated, may occur as a congenital anomaly or as the result of injury The latter condition should be distinguished from simple cohesion of the vaginal walls, in which the canal may be opened by digital examination Stenosis of the vagina occurs and may be congenital in origin or due to vaginitis or injury

Double vagina associated with double cervix and septate vagina often associated with double, septate or bicornate uterus are defects in development due to failure of the mullerian ducts to fuse Unilateral vagina in which a narrow canal runs on one side of the median line has been described in association with unicornate uterus. When a vaginal septum is present it may be represented by a mere ridge on the vaginal wall or a complete partition may be formed Often one side is larger than the other and there may be perforations in the septum.

Congenital connection between the vagina and the rectum or the vagina and the urethra may be present and may be associated with malformation of the vulva, representing persistence of the cloaca or the urogenital sinus.

The most common malformations of the hymen are abnormal rigidity and atresia. At the age of puberty imperforate hymen leads to distention of the vagina with menstrual blood.

Absence of the vulva or hypertrophy of the vulva and clitoris may be encountered, but are rare Phimosis of the clitoris is not uncommon.

Cyst and Abscess of the Bartholin Gland

Retention of the secretion of a Bartholin gland as a result of obstruction of the duct causes gradual enlargement of the gland so that it may reach the size of a walnut. The contents of such a cyst may remain mucoid or become purulent, and the abscess thus formed may perforate sponta neously to be followed by chronic inflammation in the gland. The etiologic factor in most cases is infection with the gonococcus, and the condition is often bilateral.

Urethral Caruncle

Protruding from the urethral meatus, a reddish granulomatous rounded mass is often seen particularly in older women or in women who have cystitis. Such a urethral caruncle is usually made up of granulation tissue, but in some cases the nodule is an angioma or a polyp The lesion is often associated with prolapse of the urethral mucosa.

Urethrocele and Cystocele

Both of these conditions are usually the result of childbirth and are due to stretching and injury of the supporting muscle and fascia. In urethrocele the urethra drops downward from its normal position near the pubic bone and becomes angulated, so that there is defective urinary control and a tendency to cystitis and urinary retention. Cystocele which is a herniation of the bladder downward against the anterior vaginal wall, is a common accompaniment of urethrocele and produces similar symptoms.

Rectocele

This is another common result of childbirth. The rectum bulges against the posterior vaginal wall and the latter is often pushed downward so as to protrude from the introitus.

Vesicovaginal Fistula

A fistulous tract between the bladder and vagina may appea birth injury surgical operation, radiotherapy or a chronic u ease such as syphilis. The vaginal opening of the tract is

The Female External Genital Organs, Perineum, and Vagina

PREOPERATIVE PREPARATION

The bowel should be emptied by an enema the night before operation, and on the morning of operation the bladder is catheterized. The perineum and abdomen are shaved, and in the operating room they are thoroughly cleaned with soap and water. The vagina, perineal region, upper part of the thigh, and lower abdomen are painted with an antiseptic. If the antiseptic is irritating to the skin, and all that use alcohol and acetone as a vehicle are, the liquid should not be allowed to collect on the Kelly pad under the buttocks or burns may result. General preoperative measures are the same as those mentioned in the chapter on The Uterus, Ovary, and Fallopian Tube.

LESIONS

Congenital Abnormalities

The vagina may be entirely absent or represented by a small fibrous cord, and atresia of a portion of the vagina, in which usually the lower third is obliterated, may occur as a congenital anomaly or as the result of injury. The latter condition should be distinguished from simple cohesion of the vaginal walls, in which the canal may be opened by digital examination. Stenosis of the vagina occurs and may be congenital in origin or due to vaginitis or injury.

Double vagina, associated with double cervix, and septate vagina, often associated with double, septate, or bicornate uterus, are defects in development due to failure of the mullerian ducts to fuse. Unilateral vagina, in which a narrow canal runs on one side of the median line, has been described in association with unicornate uterus. When a vaginal septum is present, it may be represented by a mere ridge on the vaginal wall or a complete partition may be formed. Often one side is larger than the other, and there may be perforations in the septum.

and careful examination may be necessary to detect the secondary opening. When a septum is present near the midline it may be cut with scissors or cautery

Atresia of the hymen is usually discovered at the time of puberty when hematocolpos and hematometra are present. Simple incision of the hymen is all that is required.

Cyst and Abscess of the Bartholin Gland

A cyst of the Bartholin gland should be excised by making a longitudinal incision in the labium over the cyst, grasping the edges of the incision with Allis forceps and by a combination of sharp and blunt dissection loosening the cyst from its bed. Blood vessels supplying the cyst are clamped and tied, and the incision is closed with a few interrupted sutures. If the cyst should be accidentally ruptured during the dissection, the finger can be inserted inside it and used as a guide to the wall of the cyst during the operation. In fact, some surgeons advise opening the cyst at the beginning and using this method of dissection. In some cases the bottom of the cyst can be grasped with a hemostat and traction on the hemostat will aid in shelling out the cyst, but because of the thin wall this method does not work as well as it does in the removal of a sebaceous cyst. When an abscess of the Bartholin gland is present, it should be drained by making an incision about 1 cm. long over the cyst just inside the labia, and inserting and opening a hemostat to allow the pus to come out. The sac should not be removed until the inflammation has subsided.

Urethral Caruncle

Diathermy or cautery should be used to remove the granulomatous mass and care should be used not to burn the tissues too deeply It is better to repeat the procedure later if necessary

Urethrocele and Cystocele

These conditions should be corrected if they produce symptoms, but it may be desirable to postpone the operation until after the childbearing period. In elderly women, the use of a pessary may be indicated instead of surgery

Technique of Anterior Colporrhaphy

With the patient in the lithotomy position a weighted retractor is inserted into the vagina and the cervix is grasped with a tenaculum and pulled downward. A transverse incision 2 or 3 cm. long is made at the base of the cervix, and from the center of this a longitudinal incision is made along the anterior vaginal wall almost to the urethra (Figure 195A) The edges of the incision are grasped with Allis forceps and dissected laterally as far as possible. The bladder is now freed from its at

by a slight elevation or wrinkling of the mucous membrane, and a probe can be inserted through the opening into the bladder If difficulty is encountered in locating the opening methylene blue may be instilled into the bladder while at the same time the anterior vaginal wall is watched for the point of leadage.

Rectovaginal Fistula

A fistulous opening between the rectum and vagina may follow an operation on the perineum or may be the result of fistula in ano perirectal abscess or carcinoma of the cervix or rectum. The treatment of such tumors by radium may also result in a rectovaginal fistula. A probe should be introduced through the vaginal opening into the rectum to determine the course of the fistulous tract.

Tumors of the Vulva and Vagina

Carcinoma of the vulva usually of the epidermoid type is not an uncommon lesion and may develop in an area of leukoplakia. The tumor appears as a warty growth, which soon ulcerates or may go on to form a cauliflower like fungating mass that metastasizes to the inguinal glands. Carcinoma may also develop in a Bartholin gland, in the urethra, or in the vestibule.

Adenomyoma may develop in the rectovaginal septum, where it appears as a rounded mass under the posterior vaginal wall. Other benign tumors of the vulva and vagina are rare but fibromyoma, lipoma, and angioma may be encountered.

TREATMENT AND TECHNIQUE

Congenital Abnormalities

Complete absence of the vagina is usually associated with absence of the uterus, and although it produces no physical symptoms, several operations have been devised to provide an artificial vagina. In the Baldwin operation a loop of ileum is isolated, the intestinal continuity re-established and the loop brought down with its blood supply between the bladder and rectum. Later the septum between the two limbs of the loop is crushed. Another type of artificial vagina is made by rotating a tube flap of skin from the thigh into an opening made into the perineum.

When partial atresia of the vagina is present the problem is less complicated. After the tract is opened up skin grafts may be introduced or mucous membrane from the labia may be transplanted to cover the raw surface. Stenosis of the vagina in many cases may be treated by gradual dilatation.

Double vagina usually produces no symptoms and its presence may not be known to the patient. Many times one side is larger than the other

tachments near the cervix and, largely by gauze stripping but with judicious use of sharp dissection it is pushed upward (Figure 195B) the pillars being cut on each side. The bladder is held temporarily out of the way by a retractor (Figure 195C) while a series of interrupted sutures of chromic catgut are introduced as far out in the musculofascial tissue on each side as possible (Figure 195D) This row of sutures is continued down to the cervix, the redundant vaginal flaps are trimmed off and the edges of the vaginal incision are approximated by a continuous submucosal stitch of chromic catgut (Figure 195E)

Watkins-Wertheim Transposition Operation

When a very large cystocele is present in a woman past the menopause and when the uterus and adnexa are normal, this operation may often be used to advantage. The first part of the procedure is the same as has been described under anterior colporrhaphy After the bladder has been dissected upward and held out of the way the uterovesicle fold of peritoneum is incised transversely thus opening the peritoneal cavity A hand or an instrument is introduced to grasp the fundus of the uterus and pull it forward through the peritoneal incision, thus placing the body of the uterus under the base of the bladder The upper edge of the peritoneal incision is attached by a few interrupted sutures to the posterior surface of the uterus somewhat above the level of the internal os The fundus is fixed in position by suturing the musculofascial layers from each side to the uterus and to each other After trimming off excess tissue from the vaginal wall on each side, the edges of the incision are sutured together by a continuous submucosal stitch of chromic catgut. After the repair of a cystocele a posterior colporrhaphy should be performed routinely

Rectocele

Herniation of the rectum against the posterior vaginal wall should be corrected if it produces or seems likely to produce symptoms, but operation can usually be postponed until after the childbearing age.

Posterior Colporrhaphy

Hemostats are applied at the vulvovaginal junction on each side far enough from the midline in front to assure adequate size to the outlet. While tension is made on these hemostats, a transverse strip of mucosa is excised with scissors the hemostats and the tissue they grasp being cut off in the process (Figure 196A) The hemostats are now applied to the anterior lip of the incision and, with the addition of a third hemostat in the midline, the posterior vaginal wall is held up while it is separated from the rectum by a combination of gauze stripping and sharp dissection (Figure 196B) If an unusual amount of bleeding from enlarged veins is encountered in dissecting up the flap, no attempt should be

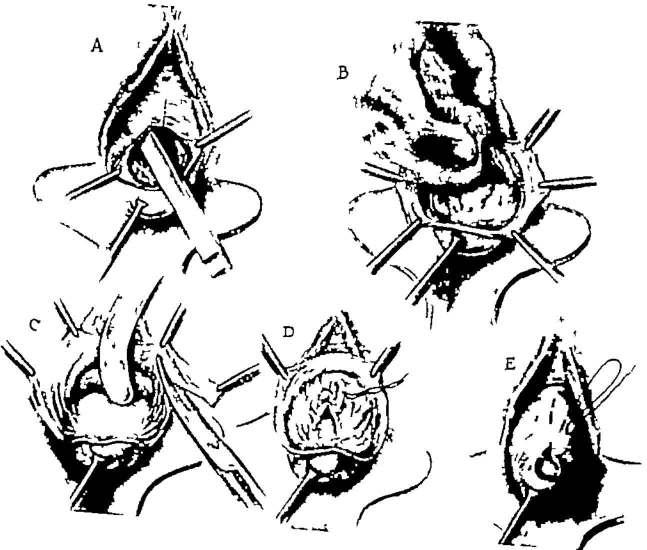


FIG. 185 *Anterior Colporrhaphy* A. A transverse incision has been made at the base of the cervix, and from this an incision passes upward toward the urethra. The vaginal wall is being separated from the cervix. B. By gauze stripping, the bladder is being separated and pushed upward. C. The bladder is held up by a retractor while excess vaginal wall is removed with scissors. D The musculofascial layer is being closed by interrupted sutures. E. The vaginal wall is being brought together by a submucosal stitch.

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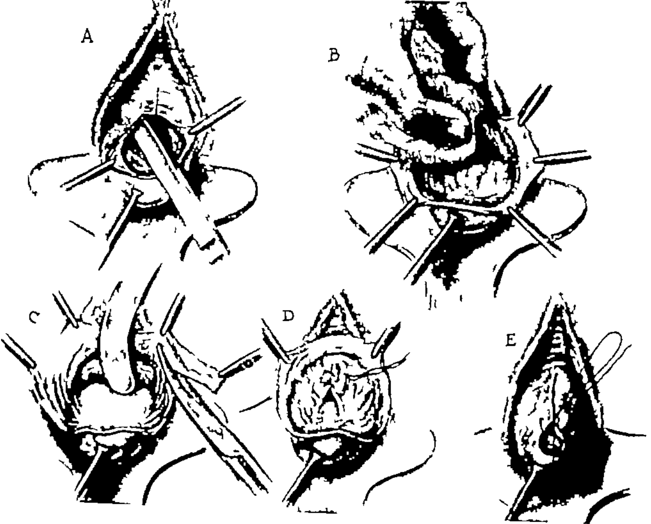


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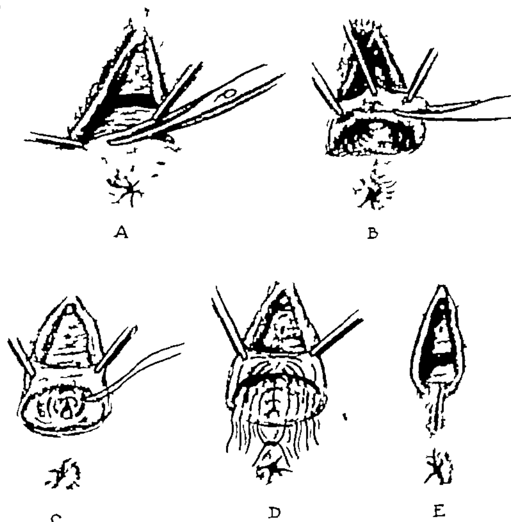


FIG. 196. *Posterior Colporrhaphy* A. Hemostats have been applied to the vulvovaginal junction and a strip of tissue between them is being excised B By gauze stripping, the posterior vaginal wall has been freed from the rectum and excess vaginal wall is being removed with scissors. C. The levatores are brought together by a few interrupted sutures. D A number of sutures are inserted, each of which begins just inside the vulvovaginal juncture, takes a bite in the levatores, then in the vaginal wall, back to the levatores and out, after taking a bite just inside the vulvovaginal juncture on the opposite side After all the sutures are put in, they are tied in the order of insertion. E. Result at the completion of the operation.

made to grasp and tie all of the vessels, but the dissection should proceed expeditiously Gauze pressure is usually sufficient to keep the hemorrhage under control until the sutures are put in. As the dissection proceeds inward, a median longitudinal incision may be made extending upward about 3 cm. The vaginal flaps are then dissected laterally as far as possible In the lower part of the field, the levator ani muscles will

be felt covered by fascia and, with the vaginal margins held aside, three or four deep chromic catgut sutures (Figure 196C) are put in between the adjacent sides of the levatores. The vaginal flaps are now trimmed as required, hemostats are reapplied to hold up the flaps and a series of interrupted sutures are put in in a counter-clockwise fashion (Figure 196D) The first suture starts near the midline posteriorly just inside the skin of the posterior edge of the incision, passes into the joined levatores, and then into the base of the anterior flap. Crossing the midline, another bite is taken in the levatores on the other side, and the suture ends by penetrating the posterior edge of the incision just inside the skin margins. The second suture starts about .5 cm. lateral to the first and pursues the same course, always staying about .5 cm. outside the first suture. A third and fourth similar suture are introduced, each .5 cm. peripheral to the previous one. After all the sutures are introduced, they are tied in order beginning with the first (Figure 196E) If the skin margins are not accurately approximated throughout, after the sutures are tied a subcuticular stitch of fine chromic catgut may be introduced, either as a few interrupted sutures or as a continuous suture.

Vesicovaginal Fistula

After the location of the fistula has been determined it should be carefully inspected. If small it may be cured by fulgurating the edges If this is not successful, or if the opening is somewhat larger, the edges of the opening may be excised and closed by concentric pursestring sutures that avoid the mucosa of the bladder If these simple methods do not suffice one may freshen the edges and employ silver wire as a suture material. This has been recommended ever since the time of Sims and is reported to give good results, but I have not used it myself For the larger fistula, or for one resistant to the above-described treatment, it is necessary to make a transverse incision distal to the fistula and dissect off the anterior vaginal wall for a considerable distance around the fistula (Figure 197C) After freshening the edges of the bladder opening, the bladder wall is closed with interrupted sutures of chromic catgut that do not penetrate the mucous membrane of the bladder (Figure 197D) The musculofascial coat that underlies the vaginal wall is now approximated over the bladder and the vaginal wall is closed with interrupted or continuous sutures of catgut. When the fistula is located high up in an inaccessible region, the pararectal incision of Schuchardt may be of considerable value in the exposure (Figure 197C) With the use of a knife a cut is made in the posterior vaginal wall along the lateral margin on one side and this is deepened to as much as 5 cm. and extended laterally so as to miss the rectum and pass backward beyond the anus. After the cut vessels are caught and tied, a retractor may be inserted and the posterior vaginal wall pushed down freely to give a wide view of the upper vagina.

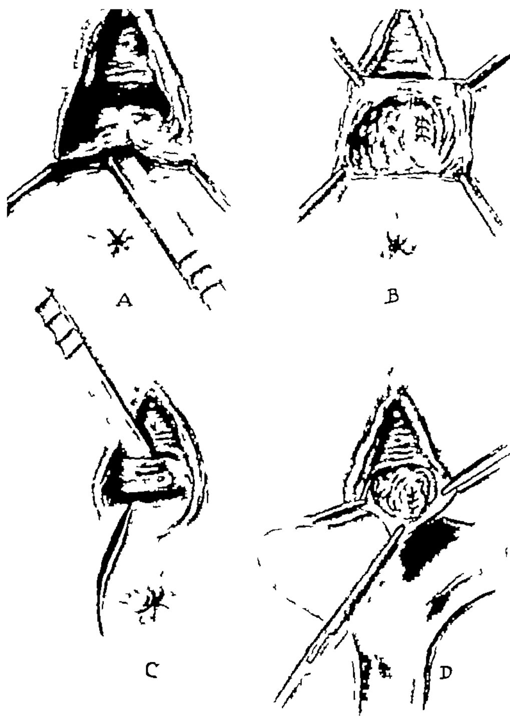


Fig 197 *Vaginal Fistulae* A. Rectovaginal fistula The posterior vaginal wall is being separated from the rectum up to and around the fistulous opening B The opening in the rectum has been excised and closed by interrupted sutures that do not penetrate the mucosa The levatores will be approximated by a series of interrupted sutures Following this, the vaginal mucosa will be brought together as in posterior colporrhaphy C Vesicovaginal fistula The anterior vaginal wall is being separated from the bladder The lateral relaxation incision shown is used when the fistula is deeply placed D The opening in the bladder has been excised and closed with interrupted sutures that do not penetrate the mucosa of the bladder The musculofascia and vaginal wall will be closed in layers.

After the completion of the operation, the incision is closed by one layer of sutures in the depth of the wound and a subcuticular suture under the vaginal mucosa and skin. A de Pezzer catheter is left in the bladder for about a week after the repair of the fistula.

Rectovaginal Fistula

Fulguration may be used on the mucosa at the circumference of the fistula, and this treatment may be repeated at intervals if necessary When the opening of the fistula is of fairly large caliber it will be necessary to do an operation similar in principle to that described under vesicovaginal fistula. A transverse incision is made through the posterior vaginal wall and the vaginal flap is dissected upward and laterally as though one were doing a posterior colporrhaphy (Figure 197A) When the fistulous opening is reached, the incision is extended around it and the opening is excised. The rectum is separated carefully from its attachment to the vaginal wall and the opening is closed by interrupted sutures of catgut that do not penetrate the mucosa of the rectum (Figure 197B) The musculofascial tissues on each side are then brought together over the rectum, and the vaginal incision is closed by submucosal sutures of catgut.

Tumors of the Vulva and Vagina

Benign tumors should be excised. Epithelioma of the vulva without evident metastasis to the inguinal glands should be treated by wide excision of the tumor followed by X ray treatment in the region of the inguinal glands but if the inguinal glands are enlarged it is better to remove them.

POSTOPERATIVE CARE

The postoperative treatment is in general the same as that outlined in the preceding chapter In the case of a vesicovaginal fistula, a de Pezzer catheter is left in the bladder for a week to give the incision time to heal. The bladder should be irrigated twice daily with boric acid solution under low pressure, and sulfonamides should be administered. After an operation for rectovaginal fistula, the patient should be given a low residue diet and the bowel should be kept from moving for about five days using one half grain of powdered opium twice a day if necessary If fecal matter should become impacted in the lower bowel it must be evacuated by enemas, using a small catheter to introduce the fluid and giving the injection under low pressure. Most of these cases require the use of an indwelling catheter for several days.

CHAPTER XXIV

The Kidney and Ureter

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The Kidney and Ureter

PREOPERATIVE PREPARATION
INCISION
LESIONS OF THE KIDNEY AND URETER
- Developmental Anomalies
- Anomalies of the Ureters
- Pyelonephritis
- Perinephritic Abscess
- Pyonephrosis
- Tuberculosis of the Kidney
- Hydronephrosis
- Injuries
- Renal and Ureteral Calculus
- Tumors of the Kidney and Ureter
- Strictures and Kinks of the Ureter

TREATMENT
- Developmental Anomalies
- Anomalies of the Renal Vessels
- Anomalies of the Ureter
- Pyelonephritis
- Perinephritic Abscess
- Pyonephrosis
- Tuberculosis of the Kidney
- Hydronephrosis
- Injuries of the Kidney
- Renal and Ureteral Calculus
- Tumors of the Kidney and Ureter

TECHNIQUE
- Nephropexy
- Resection of a Part of the Kidney

The Kidney and Ureter

Great accuracy of diagnosis is made possible by cystoscopic examination with catheterization of the ureters and the use of retrograde or intravenous pyelograms, and a thorough examination should of course be carried out before any operation is done on the kidney Even when the diagnosis is obvious as in certain cases of ruptured kidney the surgeon should never allow himself to be hurried into doing a nephrectomy when the simple procedure of intravenous pyelography will prove that the other kidney is present and functioning

PREOPERATIVE PREPARATION

In addition to the examination and laboratory procedures that are routine before any major surgery special investigations with reference to the kidney should be made Kidney function is determined by phenosulphonephthalein or by indigocarmine when cystoscopy is performed. The non-protein nitrogen, urea, and creatinine content of the blood should be estimated, and when stones are present the serum calcium and phosphorus should also be determined. If there is a tumor of the kidney X rays should be taken of the skull chest and long bones to rule out metastasis. Adequate fluid and salt intake should be assured, and if obstruction that can be relieved by ureteral catheter is present, drainage should be established and operation postponed until there has been maximum improvement.

INCISION

In nearly all operations on the kidney and for all operations on the upper half of the ureter a lumbar incision is used. The patient is placed on his side on the table with a lift arranged so as to flex the body and give the greatest possible distance between the margin of the ribs and the iliac crest. The upper leg should be straight and the lower leg bent at the knee. The incision begins just below the twelfth rib and about 6 cm. from its tip, and makes a faintly S-shaped curve as it passes downward

and laterally to end about 4 cm. above the iliac crest (Figure 198) When the subcutaneous fat has been incised, Petit's triangle, made by the latissimus dorsi and external oblique muscles and the crest of the ileum,

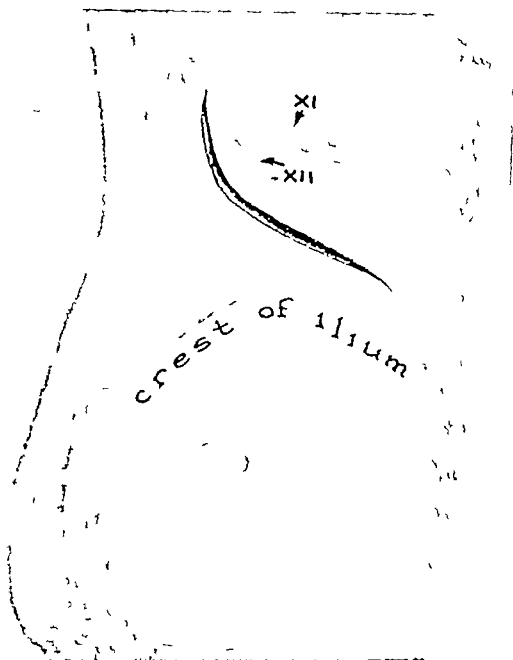


FIG 198. *Nephrectomy Incision.*

will be exposed. The incision is deepened through the latissimus dorsi and the external and internal oblique muscles (Figure 199) down to the lumbodorsal fascia, the muscles are retracted, and the fascia is incised to expose the perirenal fat (Figure 200) The ileoinguinal and ileohypogastric branches of the first lumbar nerve should be identified in the lower

part of the wound and pulled out of the way as the incision is made. At the upper angle of the wound the costal vertebral ligament, which holds down the twelfth rib, may be divided (Figure 201) but care should be taken at this point not to penetrate the pleura. If such an opening should inadvertently be made, the edges of the pleura should be caught with hemostats and the opening closed with a running suture of catgut on a

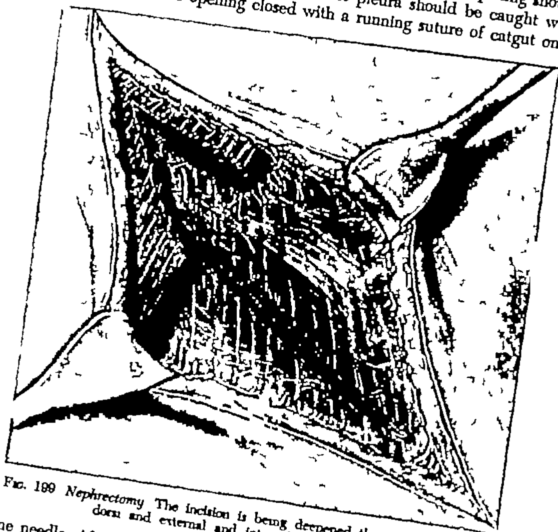


FIG. 199 *Nephrectomy* The incision is being deepened through the latissimus dorsi and external and internal oblique muscles.

fine needle. After division of the costal vertebral ligament the twelfth rib can be pulled upward slightly and, if necessary a portion of the attachment of the quadratus lumborum may be cut to give additional mobility to the rib. The perirenal fat is now stripped away enough to give access to the kidney which, with the organ held in the hand, is freed, if necessary tying accessory vessels that may enter either pole. The kidney is delivered into the wound and is now held in place only by the renal vessels and the ureter In delivering the right kidney one should use particular care to avoid the duodenum which is in contact with it. One should also remember that the renal vein on the right is shorter than that on the left and may be torn if too much tension is made on it.

The kidney is now carefully inspected and palpated, with particular attention paid to its general size consistency, regularity and to the distribution of the blood vessels. The ureter should be isolated and followed

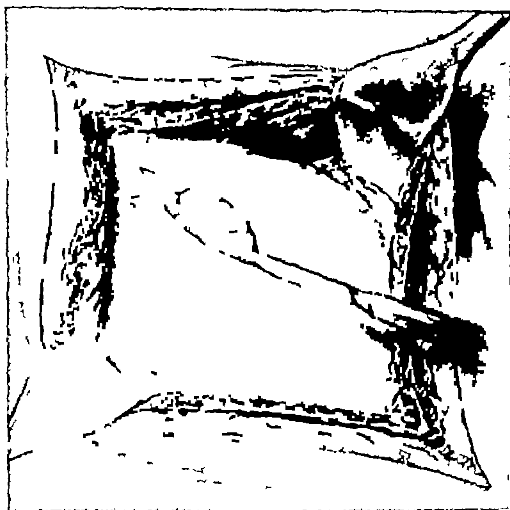


FIG. 200 *Nephrectomy* The lumbodorsal fascia is being incised, exposing the perirenal fat

down as far as may be indicated, and the presence of dilatation thickening, kinks, or stones should be noted.

At the conclusion of the operation the lumbodorsal fascia should be sutured with a continuous suture of chromic catgut, and a similar continuous layer is used for the cut muscle. A soft rubber drain may be left in the renal fossa but it is not necessary in clean cases. The skin should be closed with interrupted sutures of silkworm or dermal.

LESIONS OF THE KIDNEY AND URETER

Developmental Anomalies

There are a large number of possible developmental defects in the kidney and ureter Incomplete development of the kidney may vary from

complete absence of one kidney to congenital atrophy and fetal lobulation. When one kidney is missing there tends to be compensatory hypertrophy of the other kidney and any defect in renal development predisposes to

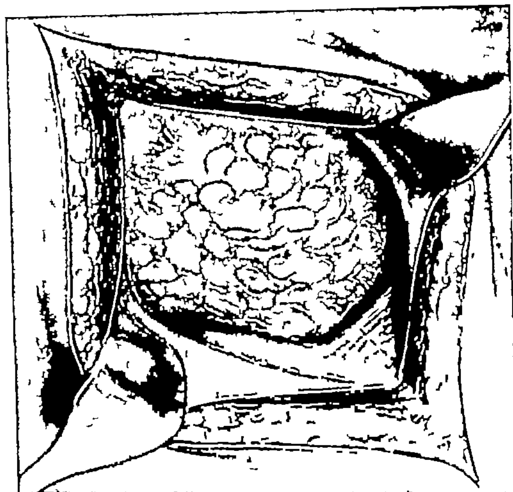


FIG. 201 *Nephrectomy* The perirenal fat is exposed. The dotted line marks the incision in the costal-vertebral ligament.

disease of the kidney in later life. Fetal lobulation, a persistence of the irregular surface seen in intrauterine life, is usually bilateral and in itself produces no symptoms.

During the course of development, the kidney may be arrested in its upward course and may be found in the pelvis, at the level of the promontory of the sacrum, at the bifurcation of the aorta, or higher It becomes fixed in the abnormal position and should be differentiated from a movable kidney the latter being one which originally was in the normal position but later dropped downward.

Fusion of the kidneys may occur and takes place most commonly at the lower pole, when the condition is called horseshoe kidney When the upper pole of one kidney is fused to the lower pole of the other it is

called a sigmoid kidney The two organs may be connected together by renal tissue or by fibrous bands.

Anomalies of the renal vessels occur very frequently and most commonly in the form of accessory vessels entering one of the poles of the kidney more commonly the upper

In this classification should be placed the condition known as congenital cystic kidney a disease affecting both kidneys in which the renal tissue becomes almost entirely replaced by large cysts and both organs become enormous in size.

Anomalies of the Ureters

There may be complete absence of the ureters, or a double ureter may be present on either or both sides, the latter condition being commonly associated with some abnormal condition in the kidney

Pyelonephritis

In this condition the kidney is usually enlarged and, when the capsule is stripped off minute yellow spots which represent small abscesses are seen. Sometimes a dark-colored patch will be noticed, which is due to infection of the lymphatics in the substance of the organ. If a small abscess on the surface of the kidney ruptures through the capsule an infection of the perirenal tissue occurs.

Perinephritic Abscess

This commonly results from the rupture of an abscess on the surface of the kidney A great deal of thick pus forms in the cellular tissue surrounding the kidney and may even bulge outward.

Pyonephrosis

In this condition the kidney is usually considerably enlarged and there is dilatation of the pelvis and destruction of the kidney tissue so that the organ in extreme cases resembles a thin walled bag of pus. The disease is often associated with stones in the kidney and frequently is bilateral. Sometimes pyonephrosis may be the result of infection of hydronephrosis. When it is associated with obstruction of the ureter there will be dilatation of the ureter and infection of the ureter itself.

Tuberculosis of the Kidney

This may be of the acute miliary form when it is associated with miliary tuberculosis elsewhere in the body but the chronic form of tuberculosis of interest to the surgeon commonly involves only one kidney for some period of time. In the early stages there may be little enlargement of the kidney and the only evidence of the disease may be grayish or yellowish areas in the cortex. As the disease progresses the kidney becomes en-

larged so that it may be two or three times normal size, and the surface tends to become irregular and lobulated and the pelvis becomes filled with pus. Secondary to tuberculosis of the kidney there may be involvement of the ureter, so that it becomes diffusely thickened and may appear dilated and stiffened.

Hydronephrosis

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Tumors of the Kidney and Ureter

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There may be complete absence of the ureters or a double ureter may be present on either or both sides, the latter condition being commonly associated with some abnormal condition in the kidney

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This commonly results from the rupture of an abscess on the surface of the kidney A great deal of thick pus forms in the cellular tissue surrounding the kidney and may even bulge outward.

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will be observed. These are due to obstruction of the renal tubules with dilatation and produce no symptoms Rarely a thin walled cyst containing clear fluid may reach considerable size such a cyst is not considered to be due to simple retention but is more probably a tumor Occasionally hemorrhage may occur into the cavity and the fluid may be brownish in color Polycystic disease is probably a developmental anomaly and has already been described.

Other benign tumors of the kidney are adenomata, which usually remain less than 1 cm. in diameter and, more rarely fibromata, sarcomata, and angiomata.

Malignant Tumors of the Renal Parenchyma These are of two varieties, carcinoma and embryoma (Wilms tumor) Some pathologists separate out of the former class a tumor known as a hypernephroma, but since other authorities consider this an unnecessary distinction, and since the general appearance and course of all carcinomata of the kidney are similar the distinction has little practical importance. Carcinoma of the kidney causes a diffuse enlargement, at first more marked at the pole of origin but gradually extending to the entire kidney In the early stages there is a definite capsule around the tumor but later diffuse infiltration of the kidney takes place and the kidney becomes lobulated, softer than normal and cystic areas may be seen through the renal capsule. The tumor has a tendency to invade the renal vein and thus will be evidenced by enlargement and a soft mass in the lumen of the vessel. The tumor as seen in the lumen of the vein or on the cut surface of the kidney is yellowish in color and shows scattered areas of hemorrhage with degenerated cysts, sometimes containing blood and in other cases clear fluid

Embryoma This is a tumor of childhood but is found occasionally in the adult and is very commonly bilateral. The tumor is of course small at first but is frequently not recognized until it reaches extraordinary size. The surface is smoothly lobular but irregular· on section it is grayish or yellowish in color and has a more uniform appearance than does carcinoma. It may occasionally invade the ureter where it causes thickening of the walls and obstruction of the lumen.

Papilloma of the Renal Pelvis Small warty growths originate usually in the pelvis of the kidney but occasionally in the ureter and in any case tend to extend down the lumen of the ureter The tumor is very friable and the breaking off of a portion of it causes profuse hemorrhage. Implantation of a fragment of the tumor may occur in the bladder where a similar papilloma develops. Some of these papillomata are benign and others have definitely invasive characteristics.

Squamous-Cell Carcinoma of the Renal Pelvis This tumor which occurs as a result of metaplasia of the transitional epithelium, likewise extends along the ureter causing obstruction with hydronephrosis and extension to or implantation in the mucosa of the bladder

Strictures and Kinks of the Ureter

Narrowing of the lumen of the ureter may be the result of chronic inflammation which may or may not be tuberculous, and which may arise in the wall of the ureter itself or extend from a neighboring organ. Chronic inflammation of the bladder may cause a narrowing of the ureteral orifice. Injury produced by the passage of a stone or by instrumentation in bringing about its removal may result in stenosis, and stricture may result from the ligation of the ureter accidentally or following operative repair of a severed ureter Abnormal distribution of the blood vessels going to the kidney may cause pressure on the ureter or the pelvis of the kidney with partial obstruction. Kinks of the ureter may result from malposition of the kidney In the case of hydroureter due to obstruction of the ureter lower down, the upper portion of the ureter may hang down and cause angulation and obstruction.

TREATMENT

Developmental Anomalies

Many congenital abnormalities of the kidney and ureter produce no symptoms and require no treatment but in some of them, on the other hand, such as polycystic disease, the symptoms after onset may be extremely severe and no treatment is possible. Surgeons have from time to time tried puncturing the largest cysts in polycystic disease, and have even resected a portion of one or both of the enlarged kidneys, but the relief obtained by these procedures is probably not enough to make the operation worthwhile

An abnormally low position of the kidney is prone to cause kinking or angulation of the ureter with hydronephrosis When such a condition is present on one side, the kidney should be elevated and fixed in a normal position if possible, and if not it should be removed. As a rule the kidney that has never been in a normal position may be so fixed that it cannot be elevated without endangering the blood supply and nephrectomy is indicated. Usually the abnormally located kidney is palpable in an abdominal examination, and unless the organ is movable enough so that it can be manually displaced upward, it may not be advisable to attempt to approach it through the usual lumbar incision. An ectopic kidney for instance, which is located at the brim of the pelvis and apparently fixed in that position, should be approached by a lower rectus incision. After the abdomen is entered the peritoneum on the posterior abdominal wall is incised to give access to the kidney and its pedicle.

Fusion of the kidneys may require operative attention if the abnormal pressure of the median mass or the abnormal blood supply should cause obstruction to the outflow of urine, or if a tumor or an inflammatory dis-

ease, such as tuberculosis should develop in one half of the organ. The kidney is approached by a lumbar incision, which is made on the side of the diseased half When the two halves of a horseshoe kidney are held together only by fibrous tissue, the cutting of this band is sufficient, but when the union is made by renal tissue the two portions must be cut apart and the open ends closed by the method described under partial nephrectomy If the separation of the two kidneys is apparently enough to relieve the obstructive symptoms, nothing more need be done, but if a tumor or inflammatory disease is present, the corresponding half of the fused kidney should be removed. Whether or not the ureter should be removed with it will depend upon the nature of the tumor or inflammation and will of course be decided on the same basis whether the kidneys had originally been fused or not.

Anomalies of the Renal Vessels

Such a condition usually makes itself known by the development of unilateral hydronephrosis The kidney is approached by the lumbar route, the fat about the pelvis of the kidney is separated and the course and relations of the renal vessels are carefully determined. The most common cause of ureteral or pelvic obstruction is a supernumerary artery entering the lower pole of the kidney and such a vessel may be safely ligated and cut without endangering the blood supply of the kidney Obstruction usually occurs about 1 cm. below the ureteropelvic junction and is often associated with nephroptosis. If such is the case, after the aberrent artery has been cut, nephropexy should be performed.

Anomalies of the Ureter

The congenital absence of a ureter is associated with an atrophic or absent kidney and requires no treatment. *Double ureter is often associated with partial obstruction and dilatation of the ureters.* If the other kidney is normal, a nephro-ureterectomy should be done. In occasional cases it may be possible to resect one of the double ureters and improve the function of the kidney and if the interference with the outflow of *urine is due to a narrowing of the ureteral orifice,* the corresponding ureter may be cut off and reimplanted into the bladder

Pyelonephritis

When the disease is unilateral and conservative measures fail, nephrectomy is indicated. When both kidneys are involved no direct surgical attack is possible.

Perinephritic Abscess

This should be treated by drainage through a lumbar incision. If at the operation the kidney is found to be badly diseased and the other kidney is normal nephrectomy should be performed.

Pyonephrosis

When this condition comes on suddenly and is seen within a day or two after onset, catheterization of the ureter with drainage of the pelvis of the kidney will sometimes save the kidney In chronic cases of pyonephrosis, nephrectomy is indicated if the other kidney has sufficient function to support life and if the patient will stand the operation. In the seriously ill patient, and in some early cases, nephrostomy or pyelostomy may be performed and then if the patient s condition improves, nephrectomy may be done.

Tuberculosis of the Kidney

Bilateral renal tuberculosis is not amenable to surgical treatment, but unilateral tuberculosis of the kidney should be treated by nephrectomy If at the operation the ureter is seen to be grossly enlarged and diseased, it should be removed at the same time, the lumbar incision being extended around to just above the anterior superior spine of the ilium.

Hydronephrosis

In bilateral hydronephrosis treatment should be directed toward relief of the urinary obstruction which is usually located in the prostate Hydronephrosis due to the obstruction of one ureter should be treated by relieving the obstruction. A stenotic ureter should be dilated by ureteral catheter A ureteral stone should be removed, and an anomalous vessel that has compressed the ureteropelvic junction should be cut, and a ptotic kidney should be elevated and held in place. When the ureteral obstruction can be relieved by instrumentation without direct attack on the kidney nothing further should be done until the patient has been kept under observation for some time and the function of the kidney has returned as much as can be expected. In some cases the hydronephrosis is so severe that even after the relief of the obstruction the kidney resumes very little function, and if the other kidney is normal the hydronephrotic organ should be removed if it is producing symptoms. When an operation is performed to fix a movable kidney or cut an anomalous vessel, and there is considerable dilatation of the renal pelvis, it may be advisable to resect part of the renal pelvis in order to prevent pocketing of the urine above the uteropelvic junction.

When hydronephrosis is present and causing symptoms, and the etiologic factor cannot be found or removed, nephrectomy should be done.

Injuries of the Kidney

Severe crushing injuries of the kidney make nephrectomy necessary and when the other kidney is normal this is to be preferred to hemi nephrectomy but all minor lacerations of the organ should be treated

by suture. After evacuation of the hematoma from the perirenal space, the kidney should be mobilized and if necessary the pedicle grasped in the fingers and squeezed to control the hemorrhage. After the blood is sponged away a careful consideration of the nature and type of the injury is necessary to determine the best type of treatment. A laceration that involves the pelvis of the kidney may safely be sutured, and even one that extends from the pelvis into the renal parenchyma in many cases may also be closed by sutures of catgut. Occasionally a urinary fistula may persist and make nephrectomy necessary at a later date, but usually such a fistula will close spontaneously When an operation for ruptured kidney is performed late, urinary extravasation will usually have taken place into the perirenal space and infection will have set in. In such cases it is probably better to remove the kidney than to attempt sutures in an infected area. It should always be borne in mind that injury of the kidney is commonly associated with injury of abdominal viscera.

If the ureter is torn and if the other kidney is normal, nephrectomy should be done. If in the course of an abdominal operation the ureter is accidentally cut, an end to-end anastomosis should be performed. A less desirable procedure is to ligate the ureter and drop it back into the abdomen. A temporary hydronephrosis will develop in the latter case, but ultimately atrophy of the kidney will take place if the kidney is not infected. If both ureters have been inadvertently ligated and this is not discovered, postoperatively bilateral nephrostomy should be performed and later if it is impossible to pass a ureteral catheter an intra abdominal operation may be done to find and relieve the obstruction. If the obstruction is low down the ureters may be implanted into the bladder and if higher up the stenotic segment may be resected and the severed ends anastomosed over a ureteral catheter introduced from the bladder Bilateral nephrostomy or pyelostomy should also be done. Occasionally a ureterovaginal fistula may develop after pelvic surgery If this does not close after a period of several weeks the abdomen should be reopened and the ureter exposed and reimplanted into the bladder If the ureter does not drain freely a nephrectomy may have to be done later if the other kidney is functioning

Renal and Ureteral Calculus

In general a stone in the kidney or ureter larger than 1 cm. in diameter will not be able to pass down the ureter and if it becomes lodged in the ureter it will require surgical removal. Whether or not stones in the kidney should be removed depends primarily on whether or not they are producing symptoms. The presence of obstruction, pain or infection and the size and number of the stones and the condition of the other kidney all enter into the consideration. When the opposite kidney is normal a stone producing no symptoms and no obstruction may be left in place. If it is

producing symptoms or obstruction, *it should be removed by pelviolithotomy* or if the stone is so large that this is not possible even when the incision is extended into the lower pole of the kidney a nephrolithotomy may be done. The latter is the method which must often be used for the large staghorn calculus. If pyonephrosis or marked hydronephrosis is found to be present, nephrectomy should be done When stones are present in both kidneys, the poorer kidney should be operated on first and either the stone removed or if infection is present, a nephrectomy done. If the function of the better kidney however is less than 25 per cent of total normal function nephrectomy should not be carried out but nephrostomy or pyelostomy is indicated, since prolonged drainage may increase the function of the bad kidney enough so that the other kidney may be operated on. Patients with bilateral, large, staghorn calculi make poor risks for operation, and surgery should be done only as a last resort. In such cases nephrostomy with or without removal of the stone may be the operation of choice When a stone is present in the kidney and the other kidney is absent, if the stone is producing symptoms or obstruction it should be removed, and if the condition of the kidney is found at operation to be such as to cause concern about its function, pyelostomy or nephrostomy should be performed after the removal of the stone.

A stone in the upper part of the ureter is approached through the usual lumbar incision. A stone in the lower half of the ureter is more easily accessible by an abdominal incision along the right side of the *rectus muscle, or by a muscle-splitting incision down to the peritoneum.* As the peritoneum is stripped back, the ureter will be found clinging to it. It is most easily identified where it crosses in front of the bifurcation of the common iliac artery

Tumors of the Kidney and Ureter

Benign tumors of the kidney should be treated by removal of that portion of the kidney in which the tumor is located, unless this region occupies more than one-third of the kidney tissue. In the latter case nephrectomy should be done. Carcinoma of the kidney should be treated by nephrectomy and as much as possible of the renal vein should be removed, because of the tendency of these tumors to invade the vessel. After the kidney has been removed it should be opened immediately If a tumor of the pelvis invading the ureter (papilloma or squamous-cell carcinoma) is found, the incision should be extended around to a point just above the anterior superior iliac spine and the entire ureter should be resected.

Embryoma These tumors are usually bilateral but if only one kidney is involved nephrectomy should be performed. The usual approach for tumor of the kidney is the lumbar route, but in the case of large tumors, a rectus incision and a transperitoneal operation may be easier

TECHNIQUE

Nephropexy

After the kidney has been delivered into the wound, it is carefully freed, cutting if necessary any adhesions or anomalous vessels that tend to immobilize it. Since hydronephrosis and narrowing of the ureteropelvic junction are so commonly associated with a kidney that has dropped from its normal position, the pelvis of the kidney should be freed of fat and

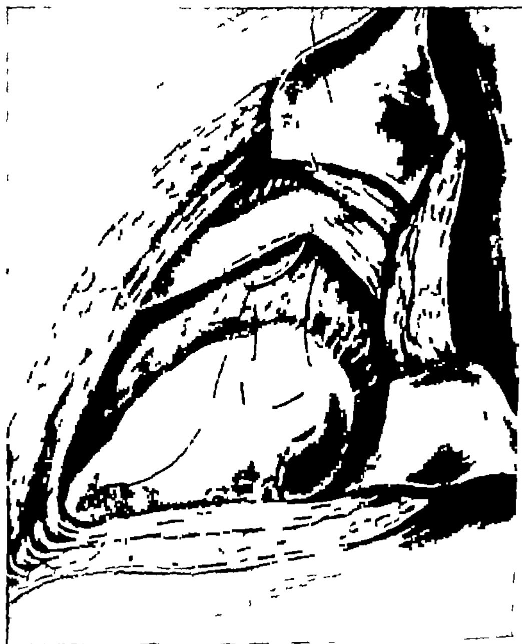


FIG. 202. *Nephropexy* A suture has been introduced into the upper pole of the kidney by Brödel's method, and the suture is being brought up between the eleventh and twelfth ribs

inspected. If the pelvis is enough larger than normal to interfere with the proper drainage of the kidney a portion of it should be excised. The upper pole of the kidney is cleared of fat and the twelfth rib is located by palpa tion. On the posterior surface of the kidney 3 or 4 cm. from the upper end, a suture of #1 chromic catgut is inserted through the capsule and into the cortex of the kidney by Brödel's method (Figure 202) With a curved needle, a bite about 1 cm. long is made into the kidney, the suture is pulled through, and then turning at right angles another similar bite is taken. The needle is then turned at right angles again and a bite is taken in an upward direction. The needle is now introduced under the twelfth rib and made to appear in the eleventh intercostal space. The other end of the suture is now threaded with a needle and is similarly passed under the twelfth rib and out. When the suture is tied, it pulls the kidney up under the twelfth rib If there is any difficulty in introducing the needle under the rib, the suture may be passed through the muscle just below the rib bed. The incision is closed by the usual method.

Resection of a Part of the Kidney

The usual lumbar incision is made the perirenal fat is freed from the kidney and any vessels supplying the portion of the kidney to be removed are clamped and tied. The line of resection should usually be one that radiates out from the pelvis. If the pedicle is sufficiently long the vessels are now manually compressed and the portion of kidney is cut off with a knife in such a way as to leave a V-shaped stump on the remaining kid ney (Figure 203) Using 0 chromic catgut, mattress sutures are now introduced through the kidney substance and capsule in such a way as to pull the limbs of the V together Usually four or five such sutures will be necessary to control the hemorrhage. The capsule of the kidney is closed with interrupted sutures of chromic catgut. No particular attention need be paid to the closing of the calices as long as the renal tissue itself is sutured.

Pelvioplasty

Excision of a portion of a dilated pelvis is accomplished by first pushing aside the fat around the pelvis of the kidney and freeing the pelvic sac carefully separating the renal vessels. The region is packed off with moist gauze, and an Allis forceps is applied to the upper portion of the region of the pelvis to be resected and another forceps to the lower margin. With sharp scissors the excess pelvic tissue is cut off care always being taken that the ureter will come off the lowest portion of the remaining pelvis (Figure 204A) A running suture of fine chromic catgut on a curved needle is now used to close the margins of the wound in the pelvis (Figure 204B) The suture should avoid catching the mucosa as

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After the kidney has been delivered into the wound, it is carefully freed, cutting if necessary any adhesions or anomalous vessels that tend to immobilize it. Since hydronephrosis and narrowing of the ureteropelvic junction are so commonly associated with a kidney that has dropped from its normal position, the pelvis of the kidney should be freed of fat and



FIG 203 *Nephropexy* A suture has been introduced into the upper pole of the kidney by Brodel's method, and the suture is being brought up between the eleventh and twelfth ribs.

inspected. If the pelvis is enough larger than normal to interfere with the proper drainage of the kidney a portion of it should be excised. The upper pole of the kidney is cleared of fat and the twelfth rib is located by palpation. On the posterior surface of the kidney 3 or 4 cm. from the upper end, a suture of #1 chromic catgut is inserted through the capsule and into the cortex of the kidney by Brödel's method (Figure 202) With a curved needle, a bite about 1 cm. long is made into the kidney the suture is pulled through, and then turning at right angles another similar bite is taken. The needle is then turned at right angles again and a bite is taken in an upward direction. The needle is now introduced under the twelfth rib and made to appear in the eleventh intercostal space. The other end of the suture is now threaded with a needle and is similarly passed under the twelfth rib and out. When the suture is tied, it pulls the kidney up under the twelfth rib. If there is any difficulty in introducing the needle under the rib the suture may be passed through the muscle just below the rib bed. The incision is closed by the usual method.

Resection of a Part of the Kidney

The usual lumbar incision is made the perirenal fat is freed from the kidney and any vessels supplying the portion of the kidney to be removed are clamped and tied. The line of resection should usually be one that radiates out from the pelvis. If the pedicle is sufficiently long, the vessels are now manually compressed and the portion of kidney is cut off with a knife in such a way as to leave a V-shaped stump on the remaining kidney (Figure 203) Using 0 chromic catgut, mattress sutures are now introduced through the kidney substance and capsule in such a way as to pull the limbs of the V together Usually four or five such sutures will be necessary to control the hemorrhage. The capsule of the kidney is closed with interrupted sutures of chromic catgut. No particular attention need be paid to the closing of the calices as long as the renal tissue itself is sutured.

Pelvioplasty

Excision of a portion of a dilated pelvis is accomplished by first pushing aside the fat around the pelvis of the kidney and freeing the pelvic sac, carefully separating the renal vessels. The region is packed off with moist gauze, and an Allis forceps is applied to the upper portion of the region of the pelvis to be resected and another forceps to the lower margin. With sharp scissors, the excess pelvic tissue is cut off care always being taken that the ureter will come off the lowest portion of the remaining pelvis (Figure 204A) A running suture of fine chromic catgut on a curved needle is now used to close the margins of the wound in the pelvis (Figure 204B) The suture should avoid catching the mucosa as

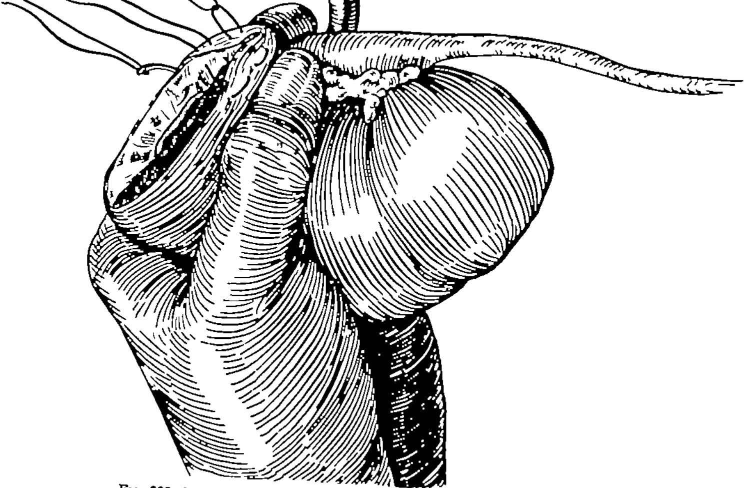


Fig 203. *Partial Nephrectomy* While the kidney is grasped in the hand to control bleeding, a series of mattress sutures is being inserted to close the wedge-shaped incision left after resection of the upper pole.

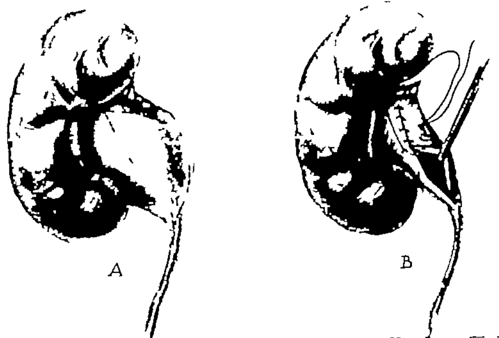


FIG. 204 *Pyeloplasty* A. Dotted line shows portion of pelvis to be resected. B After partial resection of the pelvis, the incision is being closed,

much as possible so that it will not be everted. The wound is closed as usual leaving a soft rubber drain in place.

Another procedure useful when the ureter comes off too high on the pelvis is to make an incision from the pelvis down into the ureter and suture the opening on the same principle as a pyloroplasty (Figure 205) The edges of the incision are held apart by Allis forceps, and a layer of chromic catgut sutures is inserted to close the opening in a transverse direction.

Pyelolithotomy

The kidney and pelvis having been exposed as usual the kidney is turned so that the pelvis of the kidney faces the operator It should be remembered that the pelvis of the kidney lies behind the renal vessels. With a knife a longitudinal incision about 2 cm. long is made in the pelvis extending down toward the ureteropelvic junction. The incision should not be made too close to the kidney substance, because if hemorrhage should occur in this region it is difficult to control. As soon as the urine has been discharged from the renal pelvis the little finger is inserted to feel the stone When it is located, it is manipulated down to the incision as far as possible, and a pair of curved forceps is introduced to grasp and remove it (Figure 206A) The pelvis is again explored with the finger to be sure that no other stones remain. If there is no infection, the wound in the pelvis is now closed with a running stitch of fine chromic catgut

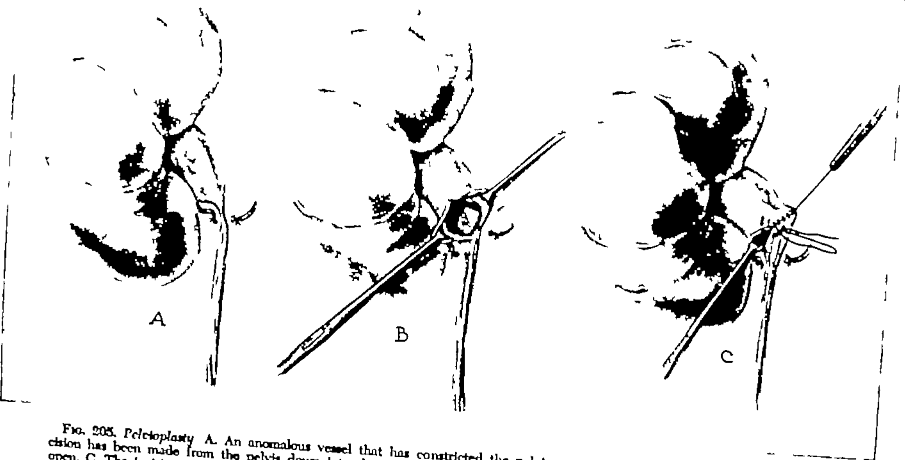


Fig. 205. *Pelvioplasty* A. An anomalous vessel that has constricted the pelvio-ureteral junction has been cut. B. An incision has been made from the pelvis down into the ureter and the edges of the incision have been grasped and drawn open. C. The incision is closed in a transverse manner

(Figure 206B) A soft rubber drain is placed in the region and the lumbar incision is closed as usual. If a pyelitis is present, it is safer to insert a small catheter into the kidney pelvis, holding it in place by transfixing it with the suture used to close the pelvis.

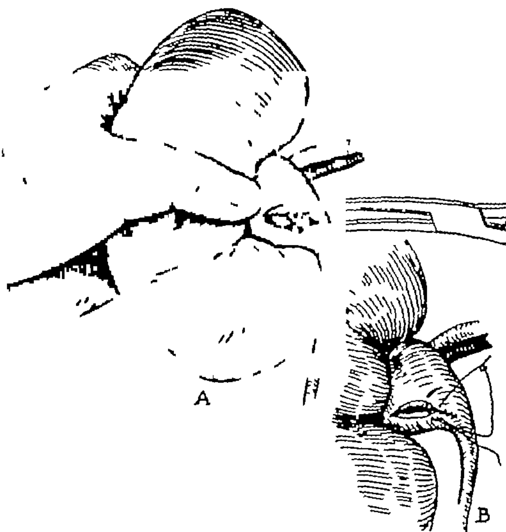


FIG. 206 *Pyelolithotomy* A. An incision has been made in the pelvis and a stone is being removed B. The pelvic incision is being closed.

Combined Pyelotomy and Nephrotomy

If it is found, after the pelvis of the kidney has been opened, that the stone is too large to be removed, the incision in the pelvis may be extended downward and outward through the posterior half of the kidney substance. It should not be extended upward or transversely because of the large posterior branch of the renal artery which runs in that region. After the stone is removed the kidney substance is closed by a series of mattress sutures, and the pelvis is closed by a running stitch.

Nephrolithotomy

Some large stones, particularly of the staghorn type cannot be removed through the pelvis of the kidney even when the incision is extended into the kidney substance itself In these cases it is necessary to make a long incision on the convex surface of the kidney Brödel s line the least vascular portion of the kidney lies just behind the convex surface and it is here that the incision should be made (Figure 207) The incision is made with a knife and when it is long enough to allow the finger to enter it, the stone is palpated, grasped with forceps, and removed, the incision being lengthened as required for the passage of the stone. The wound in the kidney is closed with a series of mattress sutures of chromic catgut through the kidney substance, and another series of sutures in the capsule. It is a safe procedure to leave a catheter with its tip in the pelvis of the kidney and extending outward from the nephrotomy wound to the outside. In addition to this, a soft rubber drain is placed in the perirenal space.



FIG. 207 *Nephrolithotomy* The stippled area shows the outline of a large stone. The incision in the kidney is made just posterior to the convex border

Nephrostomy

This procedure may be used in combination with pelviolithotomy or may be done independently to drain the pelvis of the kidney When the

pelvis has been opened, a long forceps is pushed into the kidney at Brödel's line (Figure 208) just posterior to the convex surface of the kidney and made to appear in the kidney pelvis. The forceps is opened slightly and grasps the end of a catheter and as it is withdrawn it pulls the catheter with it until the tip of the catheter lies in the pelvis of the kidney. A single suture in the capsule of the kidney may be tied around

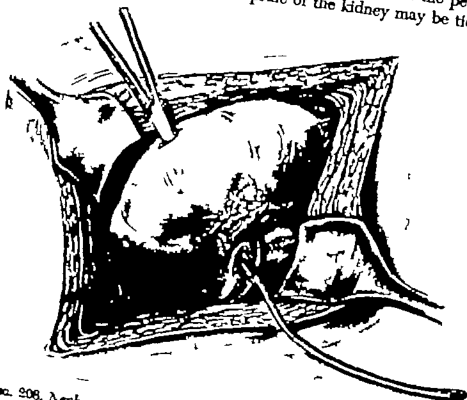


FIG. 208. *Nephrostomy* Forceps have been introduced at a point just posterior to the convex border of the kidney and are made to appear in the pelvic incision, where they grasp the end of a catheter The catheter will be drawn out until the eye lies in the pelvis of the kidney

the catheter to hold it in place or the catheter may be transfixed by the same suture. After the pelvis of the kidney has been closed, a few interrupted sutures are placed in the fat to reinforce the closure. When the pelvis of the kidney has not been opened, a similar procedure is done the forceps being introduced until the tip can be felt in the pelvis of the kidney. The forceps are then withdrawn and a soft rubber catheter is pushed through the opening made by the forceps, until it can be felt in place. A stitch in the capsule of the kidney is used to hold the catheter

Nephrectomy

After the fatty capsule has been opened, the kidney is seized and delivered into the wound, the fat is carefully removed from around the vessels at the pelvis, and if any anomalous vessels are found at either pole

Nephrolithotomy

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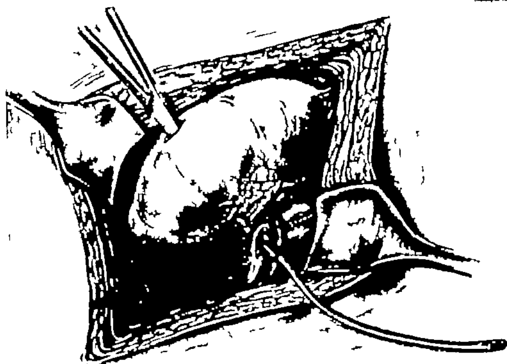


Fig. 208 *Nephrostomy* Forceps have been introduced at a point just posterior to the convex border of the kidney and are made to appear in the pelvic incision, where they grasp the end of a catheter The catheter will be drawn out until the eye lies in the pelvis of the kidney

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Nephrectomy

After the fatty capsule has been opened, the kidney is seized and delivered into the wound, the fat is carefully removed from around the vessels at the pelvis and if any anomalous vessels are found at either pole

(Figure 209) these are clamped and tied as necessary to free the kidney The ureter is separated from the pedicle, three heavy curved clamps are placed on the vessels (Figure 210) and they are cut between the distal two clamps. A ligature of #1 chromic catgut doubled is used to tie the kidney pedicle, and, as the ligature is tightened, the deepest clamp is



FIG. 209 *Nephrectomy* Anomalous vessels at the upper pole are grasped by forceps.

slowly removed and the tie falls into the groove left by the clamp. A second ligature of the same material is now put on under the remaining clamp and may be used as a transfixion ligature if one is careful to introduce the needle distal to the tie which is already in place. If a transfixion ligature is used, it is passed down around the clamp and then brought around to the upper end for tying The ligature is tightened as the clamp is removed. When a nephrectomy is done for a carcinoma of the kidney because of the tendency of these tumors to invade the renal veins the latter should be exposed as far inward as possible and clamped as deeply in as can safely be done. In these cases it may be well to treat the vessels individually rather than ligate the pedicle as a whole.

If the renal vessels should inadvertently be torn, extremely severe hemorrhage results and the patient may die within a very short space of time. The hand should be inserted into the region of the pedicle the source of the stream of blood detected if possible, and the region grasped with the finger and thumb. The blood is then sucked and sponged away



FIG. 210. *Nephrectomy* The vessels are clamped preparatory to being cut. The ureter is as yet undisturbed.

until a clamp can be applied to the vessel. In some cases where the pedicle is very short, it may be impossible safely to tie the pedicle and the clamps should be left in place, the incision being closed about them as well as possible. At the end of seventy two hours the clamps are loosened, and at the end of another twenty four hours, when the crushed portion of the vessel has loosened up from the clamps, the clamps are removed.

If the pleura should be accidentally opened, it is closed with a running suture of catgut. The duodenum, which lies in close relation with the upper pole of the right kidney should be guarded when the kidney is being freed. If it should be accidentally torn, the opening should be closed by two layers of 00 chromic catgut.

When the pedicle of the kidney has been dealt with, the ureter is

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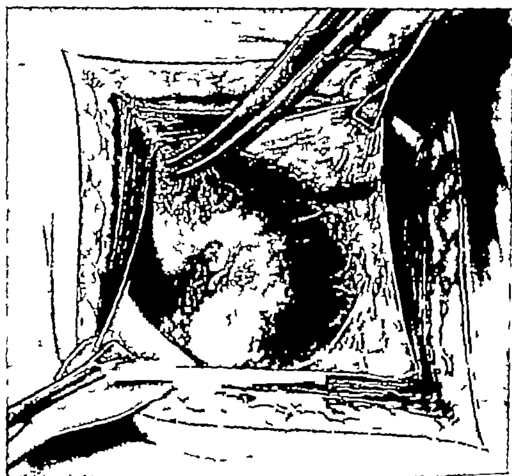


FIG. 209 *Nephrectomy* Anomalous vessels at the upper pole are grasped by forceps.

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When the pedicle of the kidney has been dealt with, the ureter is

ligated a short distance below its attachment to the kidney If the ureter is evidently diseased, or if the kidney is found to be the site of a tumor of the pelvis, the entire ureter should be removed down to the bladder The lumbar incision is extended downward and forward to about 2 5 cm. above the anterior superior iliac spine and down as far as necessary on the anterior abdominal wall. The ureter is followed down extraperitoneally until it can be ligated in the pelvis.

In some badly infected kidneys delivery of the kidney into the wound is extremely difficult and is associated with considerable hemorrhage. In such cases it sometimes facilitates the procedure to do a subcapsular nephrectomy that is, to remove the kidney but leave its capsule in place. The dissection is continued down to the kidney until the renal capsule is encountered, it is then stripped off and the old adherent scar tissue is left in the renal space When the pelvis of the kidney is reached, the capsule is divided and pushed back, so that the pedicle can be dealt with as described above.

Transperitoneal Nephrectomy

When the kidney is very large, as is so often seen in cases of carcinoma of the kidney nephrectomy through the usual lumbar approach may be difficult or impossible. In these cases a mid or lateral rectus incision is made on the side of the tumor The incision is centered at about the level of the umbilicus. When the right kidney is to be removed, the peritoneum is cut along the lateral border of the ascending colon and the colon is pulled medially until the kidney and renal vessels are exposed. On the left side the descending colon and splenic flexure are freed by cutting the peritoneum along the lateral margin and severing the phrenicocolic ligament. The kidney having been exposed, the perirenal fatty tissue is stripped back from the pedicle and kidney the ureter is identified and freed, and the renal vessels are triply clamped and ligated, as was described under lumbar nephrectomy The ureter is similarly clamped and cut. A definite advantage of this approach to the kidney is that the other kidney can be examined, but a disadvantage is that in cases of badly infected kidneys there is considerable danger of infecting the peritoneal cavity If the kidney has been cleanly removed, particularly in the case of a tumor there is no necessity for drainage· but if on the other hand, there has been some soiling, one or two soft rubber drains may be introduced to the region and brought out through the upper angle of the abdominal incision. At the conclusion of the nephrectomy the colon is allowed to drop back into place, and the peritoneum along its lateral border is sutured with a running stitch of catgut. When the ureter is dilated, or when a tumor of the renal pelvis has grown into it, the ureter should be followed down to its entrance into the bladder ligated at that point and removed.

Ureterolithotomy

When a stone is lodged in the upper half of the ureter which cannot be removed by instrumentation through a cystoscope, the usual lumbar incision is made and the ureter is located as it comes down from the kidney At the point where the stone is felt, a short longitudinal incision is made through the side of the ureter and the stone is delivered. The opening in the ureter is closed with a few interrupted sutures of fine catgut. These sutures should not enter the mucosa of the ureter A soft rubber tube is left in the wound, extending down to the region of ureterotomy

Since the level of the brim of the pelvis and the point of entrance of the ureter into the bladder are regions of normal constriction in the ureter it is at these two points that stones frequently lodge. That part of the ureter in the upper pelvis may be approached through a lateral rectus incision or a muscle-splitting incision of the McBurney type, the latter however being longer than ordinarily used for appendectomy When the peritoneum is reached, it is not opened but is stripped aside by gauze stripping until a retractor can be inserted to pull it toward the midline. As this stripping is done, the ureter should be watched for since it has a strong tendency to adhere to the peritoneum. Since the ureter crosses the common iliac artery at the level of its bifurcation, this point furnishes a landmark that will aid in identifying it, and in addition the stone itself is usually easily felt. When the ureter has been identified, a hemostat is passed underneath it and is used to pull a piece of gauze tape through to be used for traction. After the surrounding tissue has been packed off an incision is made in the ureter in the region of the stone, the stone is extracted, and a few interrupted sutures of fine chromic catgut are inserted. A soft rubber drain is left in the wound.

The McBurney type of incision is not suitable when a stone is lodged at the entrance of the ureter into the bladder For this, a paramedian mid rectus incision or midline suprapubic incision are more satisfactory Here again the peritoneum is not opened but is pushed up and the dissection extends along the wall of the bladder to the ureter which is found just below the lateral ligament.

Ureteral Anastomosis

In some cases when the ureter has been accidentally or intentionally divided, it may be necessary to suture the two ends together For this purpose very fine catgut, 00000 chromic, is satisfactory The anastomosis is most simply done by the same method used in blood vessel anastomosis. At three equidistant points on the circumference of the ends, stay sutures are introduced and used to pull the ends out in a triangular shape. A number of interrupted sutures that do enter the mucosa of the ureter are now introduced in each limb of the triangle until the entire circumference of the ends of the ureter has been sutured together

Transplantation of the Ureter

It may be necessary to transplant the ureter to another part of the bladder or to the sigmoid, and the principle and technique in either case are essentially the same. An incision about 2 cm. long is made through the

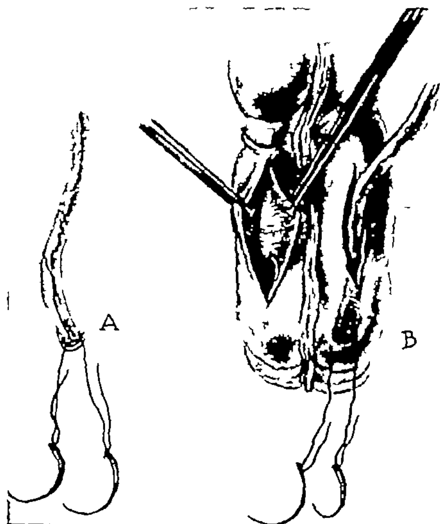


FIG. 211 *Transplantation of the Ureter* A. The end of the ureter has been split and two sutures have been fastened to it near the angles. B The serous and muscular layers of the bowel have been incised and pulled open, and a stab wound has been made through the mucosa at the distal end of the incision. On the other side, the sutures attached to the ureter have been passed through the opening in the bowel and made to emerge at a point lower down. The ureter has been drawn through the opening

muscular coat of the bowel (Figure 211B) or bladder down to the mucosa. A longitudinal slit about 1 cm long is cut in the end of the ureter In each corner of this slit a suture of catgut is introduced (Figure 211A) When these are pulled laterally the end of the ureter is flattened out. A puncture wound sufficiently large to admit the ureter is now made in the

distal end of the incision in the bladder or bowel. Needles are threaded on the sutures attached to the ureter and are introduced through the opening and made to penetrate the bowel or bladder wall about 2 cm. from their point of entrance and 1 or 2 cm. apart. When traction is made on these sutures, the ureter is pulled in through the opening (Figure 211B), and



211C. *Transplantation of the Ureter* The sutures are being fixed by taking another bite through the serosa before tying On the other side, the serous and muscular layers have been closed over the ureter

when each suture is fastened the ureter is held in place. The muscular and serous coats of the bowel are now closed over the ureter (Figure 211C) by a series of interrupted sutures, so that the ureter lies in a tunnel for a short distance With a fine needle, one or two sutures may be made between the wall of the ureter and the bowel or bladder further to hold it in place. These sutures should not enter the mucosa of the ureter or of the bladder or bowel. It is essential for this type of anastomosis to be suc cessful that there be no tension on the ureter When both ureters are to

The Bladder and Prostate

PREOPERATIVE PREPARATION

The general preoperative measures mentioned in the chapter on The Kidney and Ureter are applicable here also When residual urine is present in the bladder or when there is acute retention a catheter should be inserted. In the latter case the bladder is gradually decompressed, and in both cases prolonged bladder drainage is usually necessary For this purpose the Foley catheter is most convenient, but an ordinary catheter may be strapped in place with adhesive if preferred. By the use of liberal fluid intake, the non-protein nitrogen of the blood should come down to at most 40 mg per 100 cc. and the blood urea nitrogen to 20 mg. per 100 cc. or less. The phenolsulphonephthalein excretion should be at least 20 per cent in two hours. Vasectomy for the prevention of epididymitis, is a useful procedure and is done almost routinely in the older patient.

LESIONS OF THE BLADDER AND PROSTATE

Anomalies of the Bladder

Patent Urachus The remains of the cord running from the bladder to the umbilicus occasionally contains a duct which may discharge urine at intervals or become infected or cystic. The duct may be *blind or stenotic* for some distance at either or both ends.

Exstrophy of the Bladder This is a rare condition in which the anterior wall of the bladder and the lower abdominal wall are absent. The bladder protrudes and the ureteral orifices can be seen when the mucosa is separated. It is associated with separation of the pubic bones and there is usually maldevelopment of the genital organs.

Injuries of the Bladder

The bladder may be injured by accidental incision during the course of a pelvic operation or a herniorrhaphy Tearing of the bladder most commonly occurs in association with fracture of the pelvis.

Foreign Bodies in the Bladder

These may consist of drainage tubes, catheters or sponges which are accidentally left in at operation, or pencils or other small objects which the patient intentionally inserts. Such foreign bodies, after they have remained in the bladder for some time, become coated with urinary salts and gradually increase in size.

Calculus of the Bladder

Stones in the bladder may be single or multiple, and may cause cystitis or obstruction of the urinary drainage.

Diverticulum of the Bladder

Out pocketing of the urinary bladder is very commonly seen in association with prostatic hypertrophy but it may occasionally occur in women. The diverticula may be single or multiple and vary from .5 cm. in diameter to a sac so large as to contain as much urine as the bladder itself The neck of the diverticulum may be narrow or wide. With the narrow neck, there is associated stagnation of urine in the sac.

Tumors of the Bladder

Papilloma This is a wart like tumor that grows from the mucosa of the bladder and may be single or multiple. It has a very definite tendency to recur after removal.

Papillary carcinoma The gross appearance of this tumor is very similar to a benign papilloma, but it has more tendency to infiltrate the bladder wall and metastasis may occur in the late stages.

Squamous-cell carcinoma This tumor begins as a thickening of the bladder wall which soon ulcerates. The edges of the ulcer become thickened, and the ulcer infiltrates rapidly into the wall of the bladder Metastasis takes place relatively early

Abscess of the Prostate

This condition is commonly associated with acute or chronic gonorrhea, but may occur from other causes. Rectal examination shows enlargement of the prostate with extreme tenderness. In some cases fluctuation will be apparent.

Prostatic Calculi

Single or multiple stones are not uncommonly found in the prostate, where they may produce no symptoms or may on the other hand, cause pain or interference with urination. They are commonly associated with prostatic hypertrophy

Benign Hypertrophy of the Prostate

The lateral lobes of the gland may be uniformly or irregularly enlarged and the middle lobe may similarly increase in size, or the hypertrophy may be confined to any portion of the gland. Enlargement of the prostate causes obstruction of prostatic urethra and back pressure on the bladder ureters and kidneys. In some cases the prostate appears to be normal in size but a median bar across the posterior edge of the urethral orifice in the bladder causes the obstruction.

Carcinoma of the Prostate

The tumor may originate in any part of a normal gland, but it is often found in association with prostatic hypertrophy The gland on rectal examination feels very hard and often nodular The obstructive urinary symptoms may or may not be pronounced. Metastasis takes place to the retroperitoneal glands fairly early and very commonly metastasis is seen in the pelvis spine, femur ribs, and other bones.

TREATMENT

Patent Urachus

When a discharging duct or a cyst or abcess is present the urachus should be excised, an incision near or just lateral to the midline below the umbilicus being most satisfactory

Exstrophy of the Bladder

The only treatment for this condition is implantation of both ureters into the sigmoid and later excision of the bladder with closure of the defect in the abdominal wall.

Injuries of the Bladder

If the injury is recognized during the course of an operation it should be closed by two layers of chromic catgut. In a female patient who had had many previous operations, I once found it impossible to make a satisfactory suture of the inadvertently opened bladder because the wall was so thinned out that the sutures would not hold. I inserted a suprapubic tube, left it in place for about three weeks, and after removal of the tube the tract soon closed. In injuries of the bladder such as one sees associated with fracture of the pelvis, the bladder should be approached extraperitoneally the wound closed with two layers of chromic catgut, and drains inserted into the prevesical space If an intraperitoneal rupture of the bladder has taken place after closure of the bladder the peritoneal cavity should be drained, when there has been a great deal of infection from extravisation of urine a suprapubic cystostomy will provide a measure of safety

Calculus of the Bladder

When the stones are multiple or very large, suprapubic cystostomy should be done. Smaller stones, if not too great in number may be removed by a cystoscopic lithotrite.

Diverticulum of the Bladder

If the diverticulum empties with the bladder and is not extremely large, no surgery may be indicated, but a large sac, particularly with retention in it, should be excised. The best approach is similar to that used in supra pubic cystostomy The bladder is opened and, if the diverticulum can not be turned inside out into the bladder the wall of the bladder is fol lowed around until the neck is located. The diverticulum is cut off and the opening is closed by at least two layers of sutures.

Tumors of the Bladder

These are best treated by the transurethral implantation of radium and electrocoagulation. In the case of large tumors it may be necessary to open the bladder by a suprapubic approach, remove part of the tumor by electrocoagulation and implant radium into the remainder If the tumor does not respond to these measures, or is located in the trigone close to the ureteral orifices, cystectomy is necessary Partial cystectomy should be done if possible, and when one ureteral orifice is involved that

must be performed and both ureters must be transplanted, the latter oper ation usually being done as a preliminary procedure.

Abscess of the Prostate

When fluctuation is apparent, an abscess of the prostate may be drained through an incision in the perineum just lateral to the midline.

Prostatic Calculi

When stones are associated with prostatic hypertrophy they are treated by prostatectomy In other cases when symptoms are present, the stones should be removed by perineal prostatotomy

Benign Hypertrophy of the Prostate

Most cases of hypertrophy of the prostate should be treated by transu rethral resection but when the gland is very large one may elect to per form suprapubic prostatectomy in one or two stages

Carcinoma of the Prostate

Since prostatectomy done by either the suprapubic or perineal route does not remove the entire prostate gland, the operation is not very effec

tive in the cure of carcinoma. Young[1] has advocated removal of the entire prostate gland, the seminal vesicles and the neck of the bladder and has reported a fair percentage of five-year cures, but this operation has not been widely used.

A transurethral prostatectomy gives relief of the urinary obstruction for a time and can be repeated if necessary. There is some evidence that bilateral orchidectomy delays the progress of the disease.

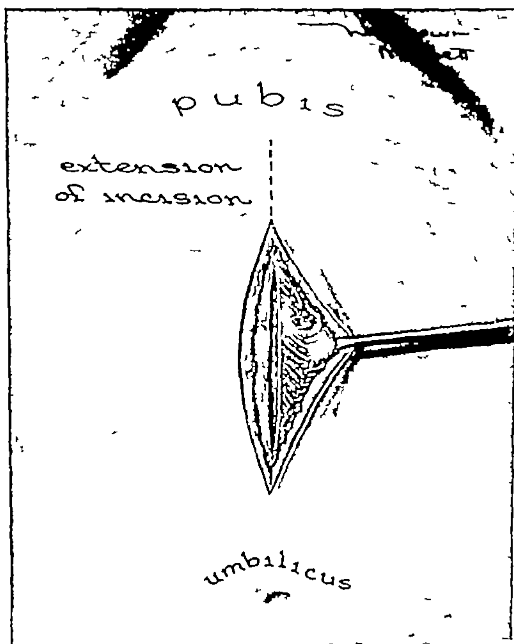


FIG. 212. *Suprapubic Cystostomy* Incision. The dotted line indicates the extension of the incision used in a second-stage prostatectomy.

1 Young, H. H. "Radical Cure of Carcinoma of the Prostate." *Am. J. Surg.* 28:32, 1935.

TECHNIQUE

Suprapubic Cystostomy

Before the operation is begun the bladder is filled with boric acid or normal saline solution by means of a catheter A midline incision 6 or 7 cm. long is made just above the symphysis pubis (Figure 212) the rectus

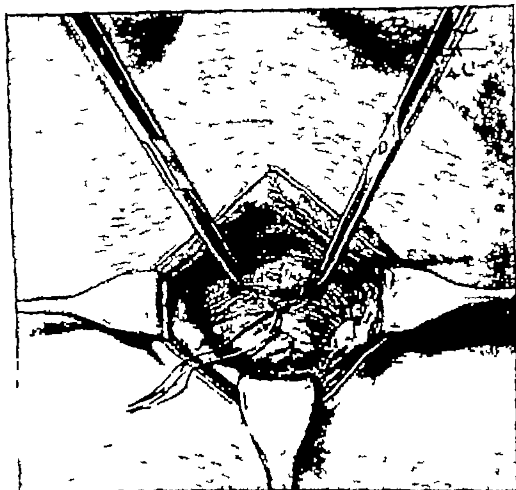


FIG. 218 *Suprapubic Cystostomy* The bladder has been exposed, a pursestring suture has been inserted, and while Allis forceps hold up the bladder wall, an incision is about to be made through it

and pyramidalis muscles are pushed to each side, the fascia is cut, and the fat in the space of Retzius is exposed. This is incised until the anterior wall of the bladder is reached. The peritoneum is usually easily recog nized in the upper angle of the wound, but if it should be accidentally cut, the opening is closed by suture. If for one reason or another it is impossible to distend the bladder before the operation is done, the exposure of the bladder is a little more difficult. The patient should be placed in a Trendelenburg position, and after a midline incision is made down to the

prevesical space the dissection should closely hug the pubic bone until the wall of the bladder is encountered. A pursestring suture is now inserted in the anterior wall of the bladder the bladder is emptied by means

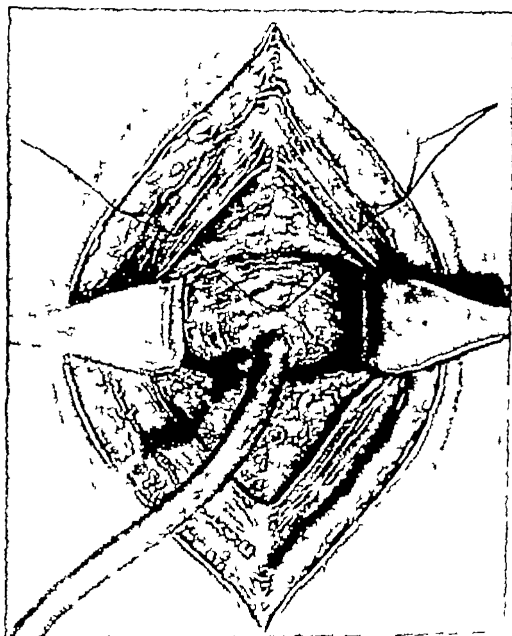


Fig 214 *Suprapubic Cystostomy* A tube has been inserted and the pursestring suture has been tightened.

of the catheter which has been left in, a stab wound is made in the center of the pursestring suture (Figure 213) and the suprapubic drainage tube, which is usually a large catheter is pushed into the bladder The pursestring suture is tied (Figure 214) and if desired the needle may be passed through the wall of the tube to aid in holding it in place, after

which the suture is tied again. If preferred, a Pezzar catheter may be used with which it is not necessary to insert a suture in the tube. The anterior rectus sheath is now closed with a continuous suture of catgut and the skin is closed with interrupted sutures of silkworm.

If it is desired to explore the bladder instead of a stab wound a transverse incision is made in the front of the bladder wall and the finger is inserted. A stone in the bladder is easily located and can be removed by grasping it with forceps. If a tumor of the bladder is present the bladder wall may be widely opened to give easy access to it so that it may be fulgurated or implanted with radium. The opening in the bladder wall is then closed in two layers, leaving sufficient space for the passage of a large catheter If the tumor is not too close to the ureteral orifices, it may often be excised without difficulty and the opening in the bladder closed by two layers of sutures, always leaving a cystostomy tube in place however If the tumor is in the region of one ureteral orifice, it may be advisable to cut and tie the corresponding ureter or transplant it into another portion of the bladder so that the region of the bladder wall which includes the tumor may be cut out.

When suprapubic cystostomy is done as a preliminary to prostatectomy the skin incision should be begun about 3 cm. above the pubic bone, so that at the second stage of the operation the prostatectomy the incision may be enlarged downward through healthy tissue (Figure 212)

Diverticulectomy

Suprapubic cystostomy having been performed and the bladder opened widely the interior is explored with the finger until the opening of the diverticulum is found. A pair of forceps is introduced into it to grasp the bottom of the sac, and under gentle tension the diverticulum is inverted into the bladder and cut off at its neck (Figure 215) particular care being used to avoid the ureter The opening left in the bladder wall is closed by two or three layers of catgut suture. When the diverticulum cannot be brought into the bladder by this method because of adhesions or because of the size of the diverticulum, it should be approached from the outside. After it is located, any adhesions present are loosened and it is cut off at its neck, after which the bladder wall is closed. A suprapubic drainage tube is left in the bladder to make sure that intracystic pressure will not cause the sutures to pull out.

Suprapubic Prostatectomy in Two Stages

This operation may be done in one or two stages, depending on the condition of the patient. When the two-stage operation is elected, the suprapubic cystostomy already described is performed, and usually at the expiration of about two weeks the second stage of the operation, the prostatectomy is done. The midline cystostomy incision is extended

downward toward the symphysis, and the opening in the bladder is enlarged. The index finger is now forcibly inserted into the vesical opening of the urethra (Figure 216), a procedure which usually tears the mucous

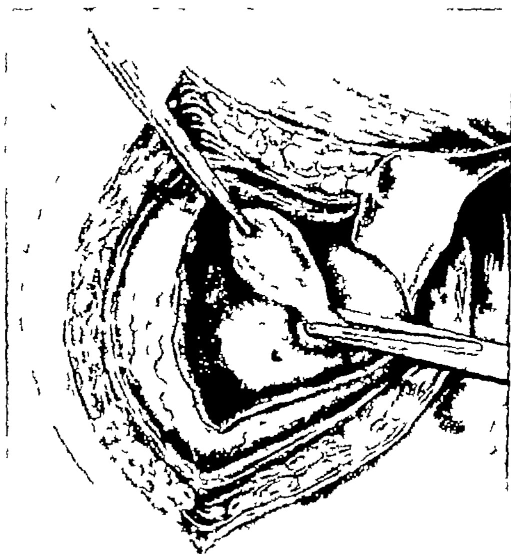


FIG 215 *Removal of Diverticulum of Bladder* A hemostat has been inserted into the diverticulum which has been inverted into the bladder where the neck is about to be cut off

membrane Starting from this break in the mucous membrane first one lateral lobe is separated from its capsule and then the finger is carried around to separate the posterior tissue and the lateral lobe on the other side is loosened (Figure 217) The urethra is torn across in this process and the prostate may come out in one piece or several After the enucleation is completed, the cavity should be explored with a finger to deter

FIG. 216. *Suprapubic Prostatectomy* The index finger has been inserted into the urethra



FIG. 217 *Suprapubic Prostatectomy* The prostate is being enucleated.

mine if there are any nodules present not already removed. A sound is now passed into the bladder through the urethra, the catheter of a Pilcher hemostatic bag is pushed onto the end of the sound, and the sound is removed, pulling the catheter into the urethra and the bag into place in the cavity left by the removal of the prostate. The bag is now inflated until hemorrhage is under control The inflating tube and upper string of the bag are brought out through the suprapubic wound, and the wall of the bladder is sutured around them and a suprapubic tube. The bag is held in place by fastening its catheter and lower string to a Hunt Hamer cage. The pressure in the bag is released somewhat at the end of twenty four hours, but the bag is not taken out of the bladder until twenty four hours later in case it has to be reinflated to control hemorrhage The cystostomy tube may be removed as soon as the danger has passed of hemorrhage into the bladder

Suprapubic Prostatectomy in One Stage

The patient is placed in the Trendelenburg position and a midline lower abdominal incision is made, extending from about 3 cm. below the umbilicus to the symphysis pubis. The muscles are separated and the incision is deepened just above the symphysis into the space of Retzius. As the incision is lengthened gradually upward the peritoneum will be recognized and pushed aside. The bladder which has been previously distended with fluid and is easily recognized by the large blood vessels on its surface, is grasped with Allis forceps. As soon as it has been emptied by opening the catheter below, the bladder is opened widely and a self retaining retractor is inserted. The removal of the prostate may be done by enucleation with the finger as has already been described, or an incision may be made over one of the prominent lobes and through this the prostate may be grasped with forceps and the dissection continued with the finger After the enucleation is completed, a row of sutures may be inserted to unite the prostatic capsule to the wall of the bladder (Figure 218) as this aids considerably in controlling hemorrhage. The Pilcher bag is now inserted as has already been described. The suprapubic tube is left in from five to seven days and then is replaced by an indwelling catheter and the suprapubic wound is strapped together with adhesive. It usually closes in about ten days

Partial Cystectomy

When the tumor involves the portion of the bladder not covered by peritoneum a suprapubic extraperitoneal approach should be used. The wall of the bladder is grasped with Allis forceps and opened in the region of the tumor Under direct vision the wall is excised well beyond the growth, and the incision is closed by two layers of catgut sutures. When the peritoneum-covered part of the bladder is affected, the ab-

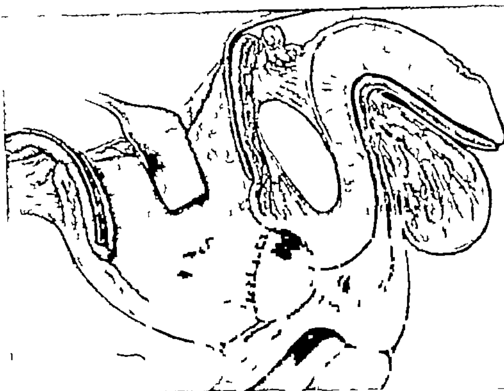


FIG. 218 *Suprapubic Prostatectomy* Suturing of the prostatic capsule to the wall of the bladder has been completed.

dominal cavity should be entered through a midline incision. The tumor can usually be felt in the bladder wall, and, after the peritoneum has been incised and stripped away the bladder is opened in that region and the affected portion cut out with scissors or the electrosurgical knife The bladder wall is closed by two layers of sutures, following which the peritoneum is sutured. A Penrose drain is inserted before the abdominal wound is closed.

Total Cystectomy

After transplantation of the ureters the bladder is exposed extraperitoneally as in cystostomy and the peritoneum is stripped upward and off the bladder The urachus is divided and tied if necessary and the dissection procedes downward on each side. Bands of tissue which run laterally to the bladder are clamped, cut, and tied, as they contain the vesicle arteries. As the posterior surface and base of the bladder are approximated, the rectum is dissected away by gauze stripping and the ureteral stumps which remain attached to the bladder are freed. The vasa and seminal vesicles may be dissected from the bladder or ligated and removed. The remaining urethral attachment of the bladder is severed at the base of the bladder and the urethra is closed with two layers of catgut sutures. A Penrose drain is inserted and the abdominal wall is closed as usual.

POSTOPERATIVE CARE

After suprapubic prostatectomy the patient on being returned to bed is given an intravenous injection of 1000 to 2000 cc. of saline solution. The suprapubic tube is connected to a bottle for continuous drainage, which should be observed carefully at frequent intervals to detect hemorrhage. The presence of more than moderate color in the fluid, the appearance of large clots or the onset of obstruction in the tube is an indication for immediate irrigation of the bladder As a routine irrigation should be performed every two hours, and oftener if there is evidence of bleeding. *Further details on the use of the Pilcher bag are given under the technique of prostatectomy* (page 574) Ordinarily a suprapubic tube can be removed in about three days providing there has been no evidence of hemorrhage in the previous twenty four hours. A urethral catheter is left in until the suprapubic wound has closed, usually in about ten days, and the bladder should be irrigated through the catheter three times a day Other general postoperative measures mentioned in the chapter on The Kidney and Ureter should also be used after surgery of the bladder or prostate.

CHAPTER XXVI

The Male External Genital Organs

The Male External Genital Organs

PREOPERATIVE PREPARATION

The usual preoperative measures are used. Patients who have an injury to the penis may have bled a great deal and transfusions are necessary When there is urinary extravasation, the patient is apt to be very toxic and, in addition to fluids transfusions may also be indicated. Scrupulous cleanliness is necessary particularly before a plastic operation on the penis.

LESIONS OF THE MALE EXTERNAL GENITAL ORGANS

Anomalies

The Penis There are a number of rare malformations of the penis due to abnormal development of the phallus genital tubercle or part of the urogenital sinus. The penis may be absent, concealed, or double. If double the glans only may be duplicated, or the accessory organ may be completely developed.

Phimosis, the presence of a small preputial orifice, is a very common congenital abnormality It should be distinguished from redundant prepuce in which the foreskin is long, but the opening is large enough to permit its retraction past the glans.

Paraphimosis, the strangulation of the glans produced by a tight retracted foreskin may be due to a congenital phimosis or to inflammatory changes in the prepuce.

A less common but not infrequently seen anomaly is hypospadias, which is a congenital defect of the anterior urethra. The urethra terminates on the under side of the penis in the glandular penile or perineal region. In glandular hypospadias, the urethra opens on the under surface of the penis a short distance from the tip the normal urethral meatus being absent or represented by a dimple. With penile hypospadias there is usually an associated down-curving of the penis. The urethra distal to the hypospadiac opening may be absent or may be present as a tube closed at one

or both ends In perineal hypospadias, the urinary opening is usually located about 3 cm. in front of the anus, and there is underdevelopment and abnormality of the external genitalia. The scrotum is often rudimentary and is represented by a fold of skin on each side of the median line the testes are often undescended, and the penis is very small.

Epispadias, an anomaly much rarer than hypospadias is a form of maldevelopment in which the urethra opens on the upper side of the penis. It may be divided into glandular, penile, and complete. In the first type the urethral orifice is usually located on the upper surface of the glans or at the region of the coronary sulcus. In the penile type the urethra opens on the upper surface of the penis just in front of the symphysis and the penis is underdeveloped and usually curved upward Complete epispadias is commonly associated with exstrophy of the bladder the penis is very small, and the urethra lies open throughout its length, the opening into the bladder being partly concealed by the upward curving of the penis and an overhanging fold of abdominal wall.

Congenital absence of the urethra is an extremely rare phenomenon but congenital imperforation of the meatus is not infrequently seen. Congenital stenosis of the meatus is very common. It has recently been recognized that congenital valves may be present in the posterior urethra and may cause many obstructive urinary symptoms, particularly in children.

The Testicle The failure of descent or incomplete descent of one or both testicles is a common anomaly With prolonged sojourn of the testicle in the inguinal canal or in the abdominal cavity atrophy of the testicle occurs and may result in permanent sterility Associated with undescended testicle, hernia and hydrocele are often seen.

Injuries and Surgical Diseases

The Penis Lacerations, contusions, rupture and traumatic amputation may occur and avulsion of the penis is not rare most of these injuries being accompanied by severe hemorrhage.

Stricture of the Urethra This may be congenital but more commonly it is traumatic or inflammatory in origin. Urinary retention and the results of back pressure on the urinary system become evident in time.

Rupture of the urethra may occur in association with crushing injuries of the pelvis or as a result of a fall astride some object. Extravasated urine passes into the tissues of the perineum and goes as far back as the triangular ligament and forward into the tissues of the scrotum, penis, and abdominal wall.

The Scrotum and Testicle Lacerations and crushing wounds of the scrotum and contents are occasionally seen. Hematocele and hydrocele may be the result of injury

Infection abscess, and gangrene may occur in the scrotal tissues as elsewhere. *Orchitis*, whether traumatic or inflammatory produces a tense, hard, and enormously swollen gland usually associated with exudation into the tunica vaginalis.

Tuberculosis frequently develops in the epididymis, and the testicle may be secondarily invaded. Associated with the disease in this location there is frequently seen tuberculosis of the prostate or seminal vesicles. The process usually begins in the globus minor of the epididymis, and firm round masses form, which gradually extend throughout the epididymis. The vas deferens will often be found to be thickened and nodular and there is commonly associated hydrocele of the tunica vaginalis As the disease extends to the testicle, the organ tends to become considerably enlarged and irregular and may become adherent to the scrotum, with fistula formation and the discharge of caseous material. The disease is often bilateral and should be differentiated from gumma of the testicle, which it may grossly resemble, except that in syphilis the lesion is primary in the testicle.

Hydrocele The accumulation of fluid within the tunica vaginalis or the vaginal process of the spermatic cord may be acute or chronic and may be on one or both sides. The fluid may be confined to the tunica vaginalis testis or may be encysted along the spermatic cord.

Spermatocele This is a cyst arising from the vasa aberentia, vasa afferentia, or the appendix testis. The fluid is milky in color and when the cyst is in communication with the seminiferous system, it may contain spermatozoa.

Varicocele Dilatation of the veins of the pampiniform plexus is very common, especially on the left side. The worm-like thickening of the vessels when palpated through the scrotum is characteristic.

Tumors

With the exception of papillomata of the penis, benign tumors of the external genital organs are rare, but malignant tumors of the penis and testicle are not uncommon.

Epidermoid carcinoma of the penis usually arises on the glans or at the coronal sulcus as a wart like growth which soon ulcerates. The ulcer may gradually enlarge or it may be replaced by a papillary fungating tumor which slowly increases in size. Metastasis takes place to the inguinal nodes and later to the lymph glands along the aorta.

Malignant tumors of the testicle are of three varieties, teratoma, embryoma and chorionepithelioma. All of these tumors produce a more or less irregular enlargement of the testicle often associated with hydrocele and metastasize by way of the blood stream or the lymphatics, the first lymph nodes involved being those deep in the abdomen.

TREATMENT AND TECHNIQUE

Phimosis and Redundant Prepuce

In congenital phimosis it may be sufficient to enlarge the opening by cutting the foreskin a short distance with scissors but the usual treatment for this and for redundant prepuce is circumcision. The edge of the dorsal

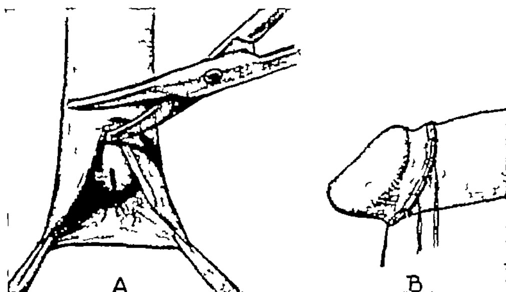


FIG. 219 *Circumcision* A. A dorsal slit has been made and scissors are being used to cut off the foreskin just beyond the corona B Interrupted sutures have been inserted to unite the skin and mucous membrane.

portion of the foreskin is grasped by two hemostats a short distance apart and using scissors the prepuce is cut back to a short distance distal to the corona (Figure 219A) Any adhesions between the prepuce and the glans are separated by gauze stripping Again with scissors the foreskin is severed around the circumference of the penis cutting across the frenum about .5 cm. from its attachment Bleeding points are caught and tied and the mucous membrane and skin are sutured together with a number of interrupted sutures of catgut (Figure 219B) The frenum is sutured to the mucous membrane by one of these sutures. Removal of the prepuce should be so planned that the foreskin left will be long enough to cover the corona. After being tied, the sutures uniting skin and mucous membrane may be left long and used to hold a strip of vaseline gauze in place to protect the region of the suture line.

Paraphimosis

An attempt should be made to reduce the paraphimosis by first compressing the edematous tissues to reduce the swelling and then pressing

the glans back as the foreskin is drawn forward. If reduction cannot be accomplished, a dorsal slit should be made in the prepuce, the incision being made with scissors or by means of a knife cutting on a grooved director and extending back almost as far as the coronal sulcus. Any bleeding vessels are caught and tied. When the edema and inflammation of the tissues has subsided, a circumcision may be done as described above.

Hypospadias

In the glandular type of hypospadias or when the deformity of the penis is not pronounced and urinary control is good, no operation may be indicated. When there is considerable curvature of the penis due to the presence of a fibrous cord and shortened skin in the median line on the ventral surface, or when the urethra opens on the shaft of the penis or near the penile scrotal junction, a plastic operation should be done to form a new urethra. The curvature of the penis should be corrected at an early age but the construction of the urethra is best done just before the age of puberty

In the first stage of the operation, a transverse incision is made through the skin on the ventral surface of the penis, and the opening thus made is pulled lengthwise with retractors the fibrous cord is identified and cut, and the opening in the skin and subcutaneous tissues is closed in a vertical direction. The method of Thiersch, about to be described, is most satisfactory for the construction of the urethra. The urine is first diverted from the region of the new canal by performing an external urethrotomy in the perineal region or by doing a suprapubic cystostomy To perform an external urethrotomy a sound is passed into the urethra and an incision about 3 cm. long is made in the midline of the perineum, extending down to the sound. The edges of the wound are grasped and pulled apart and any bleeding points present are caught and tied. The cut edges of the urethra are now grasped with Allis forceps and the sound is withdrawn. A catheter is introduced from the urethrotomy opening into the bladder In children it is not difficult to suture the edges of the opened urethra to the skin, and if this is done the catheter need not be used. In order to prevent any urine leaking into the urethra distal to the urethrotomy Horsley suggests that a silkworm suture be passed around the urethra just distal to the opening, and tied tightly enough to constrict but not cause necrosis in the urethra.

Parallel incisions are now made, one about 2 cm from the midline and the other about 1 cm. from the midline on the ventral surface of the penis extending from the level of the hypospadiac opening to the base of the glans (Figure 220A) Flaps are now turned up from these incisions so as to form a new urethra. Most of the canal will be made from the long flap and the short flap is turned up only far enough to allow it to be sutured

to the other one The base of both flaps is left attached to the penis The flaps are sutured together with a continuous suture of 00 chromic catgut over a catheter (Figure 220B) Now from the lateral side of the incision

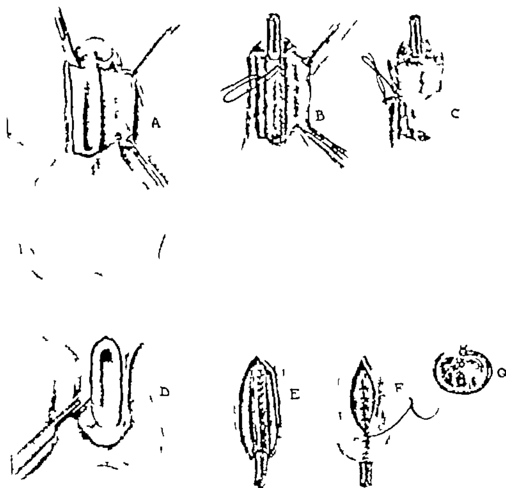


FIG. 220 *Repair of Hypospadias and Epispadias* A. *Hypospadias.* A flap is turned up on one side of the urethral groove to form the urethra, and on the other side a flap is turned up to be used to cover the newly formed tube B Formation of the tube around a catheter is almost completed C The flap is sutured over the newly formed urethra D *Epispadias* Flaps are being outlined. E Flaps have been sutured over a catheter to form a tube F The tube has been pushed toward the ventral surface of the penis, as shown in G and the corpora are sutured over it. The skin is partially closed over the sutured corpora.

on the side of the short flap another flap is turned up and dissected back far enough so that it can be pulled over to cover the newly formed urethra and be sutured to the raw edge on the opposite side (Figure 220C) The proximal end of the new urethra is now sutured to the hypospadiac urethral opening which has been freed from the skin of the penis. The urethra thus constructed opens at the base of the glans this is very satisfactory although if desired, at a later operation, a tube may be con

structed from the prepuce to carry the urethra to the apex of the glans. When the suture line has healed the perineal fistula is closed by dissecting the mucous membrane of the urethra free from the skin and inserting a few sutures into the urethral incision and skin.

In perineal hypospadias the same procedure is used, except that in ad dition the skin of the scrotum is used for part of the canal. When the artificial urethra has been reconstructed to within about 2 cm. from the perineal hypospadiac opening a suprapubic cystostomy is performed, and the suprapubic catheter is left in until a canal has been constructed between the hypospadiac opening and the newly formed urethra.

Epispadias

The extent of the operation required in these cases depends on the degree of abnormality In penile epispadias there is usually a groove on the dorsal surface of the penis extending from the epispadiac opening to the end of the penis After external urethrotomy has been performed in the perineal region, an incision is made through the skin and subcutaneous tissues about 1 cm. on each side of and parallel to this groove (Figure 220D) Flaps are freed and held up while the corpora cavernosa are separated sufficiently to allow the skin to be pushed down between them, almost to the skin on the ventral surface of the penis. A catheter is placed in this skin hammock and sutured there the corpora are brought together by a few interrupted sutures, and the skin is sutured over them by a running suture of 00 chromic catgut (Figure 220E, F and G)

When epispadias is associated with exstrophy of the bladder the ureters should be transplanted into the sigmoid and the bladder should be removed

Urethral Stricture

A stenosis of the urethra can usually be corrected by passing gradu ated sounds into the urethra on a filiform guide. In some cases it is neces sary to use a urethetome, and occasionally an external approach to the urethra through the perineum, by the same approach described under external urethrotomy may be indicated. A stricture of the urethra may be excised by this method and, as long as a bridge of mucous membrane is left the urethra will heal quite readily

Rupture of the Urethra with Urinary Extravasation

If a catheter cannot be inserted into the bladder by way of the urethra, drainage should be established by perineal urethrotomy or suprapubic cystostomy Multiple incisions should also be made in the skin of the lower abdominal wall scrotum penis, and perineum, wherever the pres ence of edema and inflammation indicates the presence of urine.

Imperforate or Stenotic Urethral Meatus

In the presence of stenosis of the meatus, the opening is enlarged by inserting a pointed knife a short distance into the meatus and cutting downward until the opening is about .5 cm. in length. A few fine catgut sutures are inserted to bring together the cut edges on each side and prevent recurrence of the stenosis. In imperforate meatus, a stab incision is made at the apex of the glans and deepened until a small catheter can be introduced into the urethra.

Undescended Testicle

When the ectopic testis is located in the abdominal cavity the consensus is that the abdominal cavity should be opened and the testicle removed, because of the danger of malignancy developing in it. An intra abdominal testis which has not descended by the time of puberty may be very small and careful search of the pelvis may be necessary to find it. When the organ is located in the inguinal canal it may or may not be possible to bring it down into the scrotum. If this cannot be done, the testicle should be removed. The usual operation for the correction of a testicle in the inguinal canal is that of Torek. An incision is made just above the inguinal ligament, extending from the level of the internal abdominal ring to the external abdominal ring The aponeurosis of the external oblique is incised, and the testis and its vessels and vas are freed from the surrounding structures. Fibrous tissue in the cord is cut so that only the essential vessels and the vas remain attached to the testicle. When the organ has been freed by this method as much as possible, it should be determined if the cord is long enough to allow the testicle to be placed in the scrotum. If this can be done, the finger is inserted into the scrotum and a pocket made for the testicle. The hernia, which practically always co-exists with undescended testicle, is now repaired by a method described elsewhere (page 197) An incision is now made about 3 cm. long through the scrotum on the lateral side and an incision of similar length is made through the skin of the inner side of the thigh down to the fascia lata The posterior edge of the incision in the scrotum is sutured to the posterior edge of the incision in the skin of the thigh. Because of the difficulty of removing these sutures at a later date absorbable sutures of catgut should be used (Figure 221A) A hemostat is now passed into the scrotum and up to the testicle the latter is grasped and pulled down and partly out of the scrotum, the hemostat is removed, and the testis is anchored with a few interrupted sutures of chromic catgut to the fascia lata (Figure 221B) The anterior margins of the scrotal and thigh incisions are now closed (Figure 221C) and the inguinal incision is sutured. The scrotum and testicle are left attached to the thigh until the testicle has become firmly fixed in its scrotal bed, usually a period of two

months or more. At the end of this time the scrotum and testicle are cut away from the thigh by incising through the juncture the testicle is replaced into the scrotum and the scrotal and thigh wounds are closed.

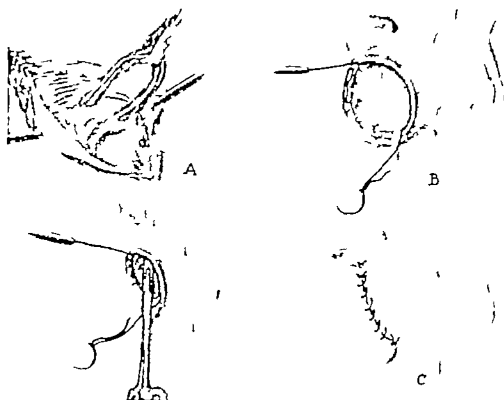


Fig. 221 *Torek's Operation for Undescended Testicle* A. The cord has been mobilized through an inguinal incision and the edge of an incision in the scrotum has been sutured to an incision in the thigh by one row of sutures. The testicle is being grasped and pulled downward. B The testicle is being anchored to the fascia lata by a few interrupted sutures C. The anterior row of sutures between the scrotum and the skin of the thigh has been completed

Tuberculosis of the Epididymis

In many cases of tuberculosis, the epididymis only is involved, and it can often be removed without sacrificing the testicle. If the testicle is found to be diseased, it should, of course, be removed along with the epididymis. An incision is made along the lateral side of the scrotum. To remove the epididymis, after cutting through the tunica vaginalis, the head of the globus major and then the body of the epididymis are freed by sharp dissection with care to avoid injuring the vessels of the testis that lie along the inner side The vas is separated up as far as possible and is doubly clamped and cut. The upper end is touched with phenol and a ligature is applied. The tunica vaginalis is sutured over the testicle and the scrotum is closed, using a continuous suture of catgut for the subcutaneous tissues and dermal suture for the skin Because of the diffi-

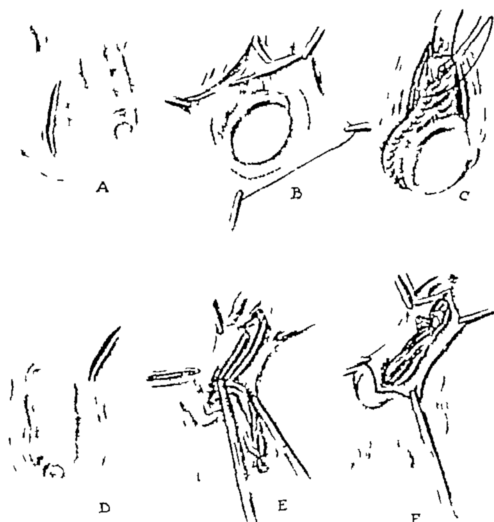


FIG. 222. *Operations for Hydrocele and Varicocele* A. In the operation for hydrocele an incision has been made on the lateral surface of the scrotum B The testicle and sac have been delivered through the scrotal incision, the sac has been opened, and the dotted line shows the area of tunica to be excised C. The tunica has been inverted and sutured around the cord. D In the operation for varicocele an incision is made in the lower inguinal region and the upper part of the scrotum. E A segment of the enlarged veins is being removed. F The lower stump of the veins is pulled up and tied to the upper one.

culty of removing sutures from the scrotum, however one may if he prefers use absorbable sutures throughout.

Hydrocele

An incision is made along the lateral side of the scrotum (Figure 222A) and a small nick is made through the tunica vaginalis. The hydrocele fluid is now either aspirated or caught in a basin, and when the sac has been emptied it is widely opened. The edges of the sac are now trimmed down until only sufficient tissue is left to allow its eversion around the testicle

and cord (Figure 222B) All bleeding points having been caught and ligated, the sac is now sutured in its everted position (Figure 222C) This, the bottle operation, gives very satisfactory results, but one may if preferred simply trim the edges of the sac down close to the testicle and not evert them. The wound in the scrotum is closed in two layers.

Spermatocele

An incision is made in the scrotum and tunica vaginalis, the testicle and cyst are delivered into the wound, and the spermatocele sac is resected. In the case of a large sac, it is more convenient to aspirate the fluid and then with the finger in the sac as a guide the dissection is easily accomplished.

Varicocele

An incision should be made beginning at about the level of the external *inguinal ring and extending down into the upper part of the scrotum* (Figure 222D) The cord is exposed and pulled up into the wound and its fascial covering is incised. The vas is identified by its hardness, and the spermatic artery should be located if possible The artery vas, and a few veins are held aside and a segment of the remaining veins about 4 cm. long is excised between clamps (Figure 222E) The upper and lower stumps of the veins are ligated and the two ends are brought together by the ligatures and tied (Figure 222F) thus supporting the testicle at a higher level in the scrotum. If the spermatic artery cannot be positively identified, most of the largest veins are dissected away from the cord and dealt with as described above. All bleeding points are carefully caught and tied, and the wound is closed in two layers.

Carcinoma of the Penis

A catheter tourniquet is applied to the root of the penis and, after any ulcerated lesions are covered with a sterile dressing an incision is made through the skin at least 2.5 cm. proximal to the apparent site of the disease (Figure 223A) The skin is pulled back for about 2 cm. and the dorsal vessels are caught and tied. At this level the corpora cavernosa and the corpus spongiosum are divided transversely leaving, however a centimeter or more of urethra projecting beyond the level of the amputation. A few sutures are inserted to control hemorrhage from the corpora (Figure 223B) The skin is now brought down over the stump and the edges sutured together in a transverse direction leaving room in the center of the suture line for the urethra, which is held in place by a few sutures to the skin (Figure 223C) The lymph glands to which carcinoma of the penis metastasizes are the superficial inguinal nodes lying below the inguinal ligament, the deep inguinal nodes beneath the fascia lata and in the femoral canal and the external iliac group of glands. If the iliac glands

are involved, complete removal of the carcinoma cannot be satisfactorily done. Bilateral incisions are made along Poupart's ligament, the skin is dissected upward and downward, and the superficial and deep nodes with fat and fascia are removed down to the external oblique aponeurosis. By gauze dissection this tissue is removed downward, freed from the fascia lata, and then the dissection proceeds inward to the region of the femoral

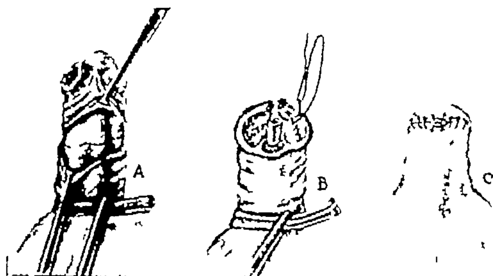


Fig. 223. *Amputation of the Penis.* A. The skin has been cut and retracted and the dotted lines show the proposed incision in the corpora. B. The urethra has been cut off distal to the corpus spongiosum and a suture is being placed in one corpus cavernosum. C. The skin edges have been closed and the urethra sutured to the skin.

artery. Nodes in the femoral canal must be very carefully removed, but as far as possible the mass of tissue is removed by block dissection down to the level of the fascia lata and the external oblique aponeurosis.

When it is necessary to amputate the penis completely an incision is made around the root of the penis, the scrotum being incised along the median line to give exposure of the corpus spongiosum. The latter is freed from the corpora cavernosa and the urethra is dissected free as far back as the triangular ligament. The crura are dissected free from the pubic bones, and the open end of the urethra is sutured to the skin in the perineal portion of the scrotal wound.

Malignant Tumors of the Testicle

An incision is made above Poupart's ligament, extending from the region of the internal abdominal ring down to the level of the external ring or onto the scrotum if the tumor is large
incising the external oblique aponeurosis.
the wound, and the cord is clamped and divided as high up as possible.

For the removal of the lymph glands extending from the internal ring

up to the level of the kidney pelvis, radical operations have been described but carry a rather high mortality

Vasectomy

This is a common procedure as a preliminary to prostatectomy to prevent epididymitis. Usually under local anesthesia, the vas is located in the upper part of the scrotum by palpation. While it is held fixed near the skin, a short incision is made down to it. A hemostat is inserted into the wound, passed around the vas, and brought up into the wound. Clamps are applied a short distance apart, and the vas is cut between them. The stumps are ligated and the wound is closed with a few dermal sutures.

POSTOPERATIVE CARE

When drainage has been established by suprapubic cystostomy or by perineal urethrotomy the tube is usually left in from eight to ten days. If stricture of the urethra is a possibility sounds are introduced into the bladder after another week. If stricture is present sounds should be passed at intervals for the next six months. Infection is treated usually by *penicillin but sulfonamides and streptomycin may be useful* Sedatives may be necessary after operations on the penis to control erections.

CHAPTER XXVII

The Bones and Joints

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CHAPTER XXVII

The Bones and Joints

PREOPERATIVE PREPARATION

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- Treatment of Compound Fractures
- Treatment of Infected Compound Fractures
- Treatment of Non Union and Delayed Union
- The Inlay Graft
- The Onlay Graft
- Fracture of the Patella
- Fracture of the Olecranon
- Fracture of the Head of the Radius
- Fracture of Both Bones of the Forearm
- Fracture of the Carpal Navicular Bone
- Fracture of the Neck of the Femur
- Skeletal Traction
- Fracture of the Spine
- Technique of Laminectomy
- Fracture of the Skull

DEFORMITY OF BONE

TUMORS OF THE BONE

- Benign Tumors
- Malignant Tumors

OSTEOMYELITIS

- Acute Osteomyelitis
- Chronic Osteomyelitis
- Brodie's Abscess

ACUTE SUPPURATIVE ARTHRITIS

DISLOCATION AND INJURY OF THE SEMILUNAR CARTILAGE

PROTRUDED INTERVERTEBRAL DISC

up to the level of the kidney pelvis, radical operations have been described but carry a rather high mortality

Vasectomy

This is a common procedure as a preliminary to prostatectomy to prevent epididymitis. Usually under local anesthesia the vas is located in the upper part of the scrotum by palpation. While it is held fixed near the skin, a short incision is made down to it. A hemostat is inserted into the wound, passed around the vas and brought up into the wound. Clamps are applied a short distance apart, and the vas is cut between them. The stumps are ligated and the wound is closed with a few dermal sutures.

POSTOPERATIVE CARE

When drainage has been established by suprapubic cystostomy or by perineal urethrotomy the tube is usually left in from eight to ten days. If stricture of the urethra is a possibility sounds are introduced into the bladder after another week. If stricture is present, sounds should be passed at intervals for the next six months. Infection is treated usually by penicillin but sulfonamides and streptomycin may be useful. Sedatives may be necessary after operations on the penis to control erections.

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The Bones and Joints

PREOPERATIVE PREPARATION

Because of the serious results that may follow infection of the bones or joints, special care is used in preoperative preparation of the skin. The evening before operation the skin in the operative region and widely around it is thoroughly washed with soap and water shaved, washed again with soap and water and then sponged off with benzine The benzine is removed with ether and the operative field is painted with a surgical antiseptic. If tincture of iodine is used, it is removed by 70 per cent alcohol The operative field is covered with sterile towels, which are held in place by bandages and adhesive tape. This dressing is left on until the patient has been placed in position on the operating table the next morning. It is then removed, and a surgical antiseptic is again applied.

When the skin is especially dirty or if calluses or exfoliation are present, the preoperative washing should be started forty-eight hours before operation and repeated several times up to the evening before surgery

When the operation to be performed will be long or associated with considerable hemorrhage, the patient's blood should be typed and blood should be available for transfusions In acute injuries when shock is present, or when there has been severe loss of blood, these conditions should be treated before surgery

FRACTURES

Most fractures are properly treated by the closed method, but in certain cases open reduction is more satisfactory or necessary Surgery must be done when a fracture cannot be reduced or held in reduction because of the location or type of fracture, or because of tissues interposed between the ends of the bone When the fracture line is oblique the bone ends tend to slide past each other as soon as the extension is removed, and internal fixation is often necessary Fractures in a joint are notoriously difficult to reduce and hold in apposition and usually require an open operation. When muscle tissue has become caught between the fragments,

no external manipulation can bring about the reduction of the fracture until this tissue is removed. Operation is of course performed in compound fractures that require debridement or removal of a foreign body and in many of these cases open reduction with or without internal fixation is indicated. In some comminuted fractures also it may be advisable to remove or replace large displaced fragments to insure proper healing of the fracture Besides these fractures requiring operation to repair the damage to the bone there are certain secondary injuries that may be present and may demand correction by operation. When a large vessel has been torn, or a nerve has been injured, or when a portion of bone is pressing on the spinal cord or on a nerve or when as in a fracture of the skull with a torn meningeal artery, extravasated blood or a blood clot is producing symptoms operation is indicated. In addition, there are those rare cases in which the fracture is due to a benign tumor of the bone, and the surgical removal of the tumor is necessary to assure healing of the fracture. Lastly operation is necessary in most cases of non-union and in those *cases of delayed union in which the prospects of cure seem remote.*

Methods of Fixation

In fracture of a long bone, of which the femur may be taken as an example, after preparation of the skin the patient is placed on a table of the Hawley type and traction is exerted to reduce the overriding of the fragments. The skin of the thigh is painted with an antiseptic, and draping and towels are applied to leave exposed only the operative field, the lateral surface of the thigh. An incision is made which is centered at the level of the fracture as determined by X ray and extended far enough up and down to provide easy access to the bone Skin towels are clipped on the edges of the wound, and the incision is deepened down to the bone. Muscle tissue is stripped away from the bone enough to gain a satisfactory view of the fragments, and any interposed tissue is removed by manipulating the lower fragment with a Lane bone holder and by judicious pushing on the tissue with the finger or an instrument. If the fracture line is more or less transverse it may be found that after the ends of the bone are engaged, no fixation other than a cast will be necessary but if there is a tendency for the fragments to get out of place or to rotate, a vitallium or stainless-steel plate should be applied (Figure 224E and F) The plate should be laid on the bone with its center at the fracture line, and held there while a Lowman plate holder is put on in such a way as to hold the bone fragments and the plate together A drill is selected that is somewhat smaller than the screws to be used, and a hole is drilled into the bone through one of the openings in the plate. The screws should be of stainless steel or vitallium threaded throughout their length, and long enough to pass almost entirely through the shaft of the bone The first screw is driven home, and then a drill hole is made and a

screw inserted at the other end of the plate into the other fragment. The remaining holes are now drilled and the screws are inserted, after which the holder is removed and the muscle is brought together and sutured over the plate. As many interrupted sutures of catgut or silk are introduced as

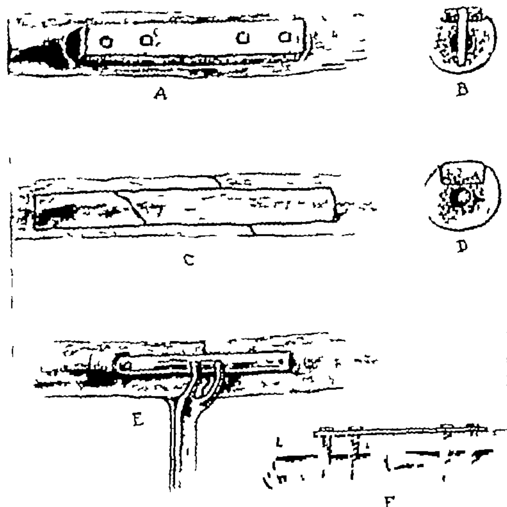
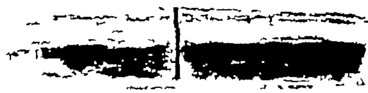


FIG 224 *Methods of Bone Fixation* A and B. Onlay graft held in position by bone pegs. C and D Sliding graft. E and F Metal plate held by metal screws.

are necessary to close all dead space in the muscle, the fascia is brought together by a similar suture and the skin is closed with silkworm or dermal. A cast should be applied, since the function of the plate is merely to hold the fragments of the bone together while healing takes place. A plate of the type described may be left in permanently unless it should become loose, or unless it has been applied to a superficial bone like the tibia.

If after the reduction of a fracture the fragments show little tendency to get out of position, it may not be necessary to use a plate. The ends





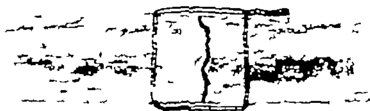




Fig 223 *Osteotomy and Fixation of Bones by Wire* A. Linear osteotomy B Wedge osteotomy C. Bone fragments held by wire passed through drill holes. D Bone fragments held by encircling wires.

of the bone may be held together by boring a hole in each and threading through and fastening a wire of stainless steel or vitallium (Figure 225C) In many cases a few strands of heavy catgut may be used in the same way, instead of wire.

When the fracture line is oblique two or more screws of vitallium or stainless steel are often more satisfactory than a plate The fragments are held together by a bone holder, while holes are drilled slightly smaller than the diameter of the screws and the screws are driven home. If the fracture is comminuted, the best method of treatment may be to encircle the whole mass of fragments with pieces of stainless steel wire and twist the wire until the bone is restored to its normal contour as much as possible (Figure 225D) In some cases a combination of screws and wire may offer the best fixation, the method used depending on the mechanical ingenuity of the operator

Treatment of Compound Fractures

The treatment of deep wounds is discussed in the chapter on The Skin and Subcutaneous Tissues, and the principles outlined there are applicable also when the wound is associated with a broken bone, except that a roentgenogram is made to determine the nature of the fracture The skin around the wound and then the wound itself are washed thoroughly with soap and water If any grease is present, it is removed with ether after which the wound is thoroughly flushed with normal saline solution and the skin is painted with an antiseptic. Occasionally a tourniquet will be necessary but it should be avoided if possible. During the procedure the part should be held in extension either by an assistant or by the use of a fracture table. The operative field is surrounded by drapes, and the condition of the wound is studied. In extensive wounds debridement should usually be done, but as a rule only if the injury occurred less than eight hours previously since compound fractures are always contaminated. The time factor is important from the point of view of infection but it is only one factor and with the use of penicillin and sulfonamides a little more latitude is permissible. An open operation should not be done on a compound fracture unless the accidental wound is already large enough, or becomes so after debridement, to permit access to the fracture. The surgery should be confined to the treatment of the wound itself and the fracture should be reduced as well as possible by external manipulation. An exception is that occasionally it may be advisable to introduce instruments to pry the bone ends into position. If debridement is to be performed, the rough edges of the skin surrounding the wound are cut away with a knife. Macerated and devitalized muscle is cut off until normal appearing tissue is present bleeding vessels are caught and tied, and if dirt and foreign bodies are present in the wound it may be necessary to enlarge the wound in order to remove them. The

wound is irrigated with normal saline solution from time to time to remove debris and gown gloves, and instruments are changed before continuing the procedure. The fracture is reduced as well as possible. Small loose fragments of bone that are entirely detached should be removed, but large fragments which may be of value in preventing shortening of the shaft of the bone, are left in place, although fragments that include the entire thickness of the cortex usually show little tendency to join on to the bone. Internal fixation by the use of metal should be avoided if possible, but if plate screws, or wire are necessary they must be used. If an injured nerve is present, it is sutured. The wound is covered well with soft parts, and sulfonamide powder may be sprinkled throughout the wound if desired. The incision is left wide open if debridement was performed, otherwise it is closed very loosely by a few interrupted sutures of silkworm gut.

In cases seen more than eight hours after injury as a rule debridement should not be done. The fracture should be reduced as well as possible and the wound is loosely packed with petrolatum gauze, with the idea of secondary closure later

A cast is applied, and, if necessary to maintain the length of the limb the two ends of the bone away from the fracture may be transfixed by Kirschner wires which are embedded in the cast, or traction may be applied to a Kirschner wire passed through the distal fragment. Fixation of the fracture may also be secured by pins attached to an external adjustable metal bar

If infection develops, the cast must be bivalved for necessary changes of the petrolatum gauze pack. Tetanus antitoxin combined with gas bacillus antitoxin should be administered, and penicillin or sulfonamides should also be administered.

Treatment of Infected Compound Fractures

If infection develops in a case treated as outlined above, the fracture should be held in reduction but free drainage should be established when necessary Any pockets found should be explored and foreign bodies removed. The petrolatum gauze pack, if not already used, should be introduced. The gauze should be put in loosely and covered by a dry dressing and the dressing is not changed until the amount of the discharge or the odor makes it necessary

If the patient is not seen until infection has already developed, the fracture should be reduced as well as possible without internal fixation. Free drainage should be established and any foreign bodies or small detached fragments of bone that are easily accessible should be removed. Petrolatum gauze is packed loosely in the wound, and a cast is applied. Chemotherapy or penicillin should be administered. The onset of gas gangrene will require multiple incisions to provide drainage throughout the por

tion of the limb involved. If massive gangrene sets in amputation is required, and the limb should be removed a liberal distance above the apparent area of involvement If the amputation is begun too low, and brownish devitalized muscle is seen, any attempt to resterilize the field and amputate higher is apt to result in infection of the stump

Treatment of Non Union and Delayed Union

If at operation the fragments are found to be in good position but united only by fibrous tissue, multiple drill holes may be made in the bone, with the perforation extending from one fragment to the other across the fracture line. Depending on the size of the bone, from six to ten or more holes should be made. If there is some separation of the fragments, or if there is loss of bone a graft should be used to hold the fragments and stimulate bone formation The ends of the fragments should be freshened by removing fibrous tissue or cartilage the fragments are brought together and an inlay or onlay graft of as large size as possible should be applied (Figure 224A and B) An autogenous graft, obtained usually from the anteromedial surface of the tibia and held in place by bone pegs or by screws of stainless steel or vitallium is the most satisfactory and convenient. Beef bone grafts are employed by some surgeons and beef bone screws may be used if they are available An intramedullary bone pegs helps to maintain alignment, but should not be used unless necessary because it tends to interfere with the blood supply to the fracture line. If there is a defect in the bone, autogenous bone chips obtained from the cortex or cancellous portion of the tibia should be placed in the space.

The Inlay Graft

The site of the fracture should be exposed and the bone cleared for some distance on each side of the fracture line. An incision is made in the periosteum and this is stripped back from the bone for a distance of 8 or 10 cm. above and below the fracture line. The bed is prepared by cutting out a strip of bone 2 cm. wide or less, depending on the size of the bone and extending 7 cm. or more on each side of the fracture line This piece of bone may be cut out with a twin rotary saw or by boring drill holes about 2 cm. apart, outlining the area to be removed and cutting between the holes with a chisel. A curved incision is now made over the tibia on its anteromedial surface, the skin is retracted, a piece of bone corresponding in size to the bed to be filled is cut out and the incision in the skin is closed (Figure 226) The bone graft thus obtained is placed so that it lies firmly in the prepared trough and bridges across the fracture line, where it is held in place by suturing periosteum and muscle over it.

If the surgeon does not desire to use bone from the tibia, the principle of the sliding inlay graft may be utilized (Figure 224C and D) A piece

of bone is excised from above and below the fracture line as before, but it is made only 6 to 8 cm. long on one side of the fracture line and 10 to 12 cm long on the other side. The position of the pieces of bone is now reversed, the long fragment being placed so that it extends across the fracture and the short fragment used to fill up the remaining space. This type of graft is not as satisfactory as one taken from the tibia, unless the fractured bone is of large size and has sustained little loss of substance.

The Onlay Graft

This consists of a massive piece of bone obtained from the tibia and contains the entire thickness of cortex down to the medulla (Figure 224A

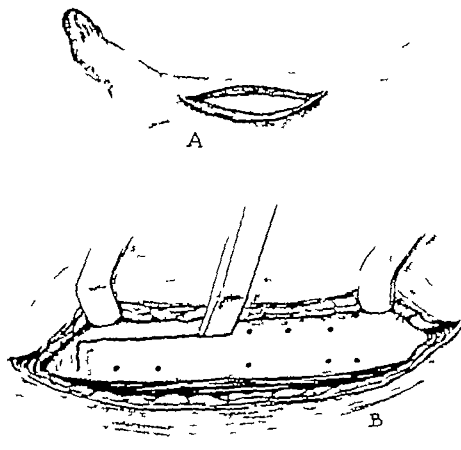


FIG 226 *Method of Obtaining Bone Graft from Tibia.* A. Incision. B After the graft has been outlined by drill holes, it is cut with a chisel If available a power saw may be used instead.

and B) The graft should be almost as wide as the bone onto which it is to be applied It is cut from the tibia with a saw or multiple drill holes are made and it is removed with a chisel. The host site should be prepared for the graft by removing part of the bone with a chisel until the surface is flat. The graft is laid on this bed and held in place by au-

togenous bone pegs inserted in drill holes. The muscle is brought together over the graft by a few interrupted sutures, and the fascia and skin are closed. The patient should be cautioned not to bear weight on the leg from which the graft was taken for about six weeks, since the loss of such a large portion of bone considerably weakens the tibia.

Fracture of the Patella

An anterior midline incision about 12 to 15 cm. long is made in such a way that it curves either outward or inward slightly around the patella. This gives good exposure of the bone but places the scar to one side of the bone. The incision is deepened to the tendon of the quadriceps, the patella, and the patellar ligament. The edges of the skin and subcutaneous tissue are retracted over the patella and tears in the lateral aponeurosis are identified. Through these, the joint is inspected for loose pieces of bone, and these together with blood clots are carefully removed. The patella is inspected, and small completely detached fragments are removed. The usual method of fixation of the patellar fragments is by means of a wire of stainless steel or tantalum. The wire should not penetrate the joint surface of the patella, but may be passed around the circumference of the bone; this is a particularly valuable method when there is comminution. Another procedure is to insert the wire transversely through the quadriceps tendon just above the patella, pass it down over the anterior surface of the patella beneath the tendonous fibers and then through the patellar tendon just below the patella. Thence the wire passes upward to form a loop when it is twisted on to the other end. Instead of these methods two holes may be bored through the fragments from the external to the fractured surface of each, and a wire threaded through the holes and tied in the form of a loop Kangaroo tendon may be used instead of wire and even several thicknesses of chromic catgut are satisfactory in many cases. The aponeurosis is repaired with chromic catgut and the incision is closed. A posterior splint is applied, and active and passive exercises with the assistance of an overhead pulley are started in ten days. The patient is permitted to walk with crutches at the end of the second week, and motion gradually increases to 90 at the end of two months. When wire is used to fix the fragments, occasionally it may be necessary to remove it, but this can be very simply done by making a small incision over the twisted ends, grasping them and cutting one wire below the twist, after which it can be easily extracted.

Fracture of the Olecranon

A posterior medial longitudinal incision is made, curving slightly at the level of the olecranon to place the scar off the surface of the bone. Any small fragments of bone present are removed, and, with proper

retraction of the margins of the incision a hole is drilled transversely through each fragment and they are tied together with stainless steel wire, kangaroo tendon or heavy chromic catgut The wound is closed and a plaster cast is applied, with the forearm at about 135 flexion. The cast is bivalved at the end of three weeks so that motion can be instituted, and the cast is discarded finally at the end of six weeks.

Fracture of the Head of the Radius

When there is a comminuted fracture of the head of the radius, or when the head is tilted due to fracture of the neck and this cannot be reduced by manipulation, operative interference is necessary A longitudinal posterolateral incision about 5 cm. long is made, and the head of the radius exposed between the anconeus and extensor carpi ulnaris muscles The external lateral and annular ligaments are cut to expose the head and neck with care to avoid the deep branch of the radial nerve, which winds around the bone as close as 2 cm. from the head. In some cases when the head is merely displaced, it may be pushed back in position and held there by suturing the muscles around it, but if the head is broken in many fragments or is displaced and impacted, it should be removed along with the upper end of the bone down to the attachment of the biceps. The stump of the bone is rounded off with rongeur forceps, and the wound is closed in layers A cast or posterior molded splint is applied with the forearm in flexion and supination.

Fracture of Both Bones of the Forearm

Two incisions should be used, one on the ulnar and one on the radial side The ulna may be exposed at any point in its extent by making an incision over the posterior surface and approaching the bone between the extensor carpi ulnaris and the flexor carpi ulnaris muscles. The radius may be exposed throughout its length by a longitudinal incision on the volar surface of the forearm. The incision is deepened through the fascia, the brachioradialis muscle and the superficial branch of the radial nerve are retracted laterally and the flexor carpi radialis and radial vessels medially The muscular attachments of the flexor digitorum sublimis and pronator teres are cut at the bone On the upper portion of the bone the supinator is reflected laterally and lower down the flexor pollicis longus and the pronator quadratus can be detached from the bone if necessary and retracted medially The operation is begun on either bone and, after the fracture area is exposed, a hole is bored in each fragment and they are fastened together with stainless steel wire or chromic catgut. The muscles are closed around the bone and the fascia and skin are sutured. The forearm is then rotated and a similar procedure is done on the other bone. An anterior molded splint is applied from the metacarpophalangeal joint to the elbow

Fracture of the Carpal Navicular Bone

When non-union of the navicular bone is present and the patient complains of disability and pain operative interference is necessary An incision is made over the anatomical snuff box just lateral to the tendon of the extensor pollicis longus. In some cases multiple drill holes between the fragments are sufficient to cause union or one may elect to bore a hole in the fragment and insert a peg of bone obtained from the tibia in such a way as to hold the two fragments together One of these procedures should be done the skin closed and a plaster cast applied so that the hand can be kept abducted and hyperextended for about eight weeks. If union does not occur it will be necessary to remove half or all of the bone by opening the previous incision and enlarging it to about 5 cm. Care should be used to avoid opening the tendon sheaths, and the extensor pollicis longus should be retracted to the medial side. The ligaments and capsule are cut over the bone and the pieces are removed. The fascia is sutured, the skin is closed, and an anterior molded splint is applied from the tip of the hand to above the middle of the forearm so as to hold the hand including the thumb in a moderate degree of dorsiflexion and some radial inclination. At the end of a week the cast may be cut off up to the metacarpophalangeal joint level so that the fingers and thumb can be exercised. Motion should be started at the wrist in about ten days but the cast should be worn for support for about three weeks. Removal of the navicular bone often results in a slight degree of permanent disability

Fracture of the Neck of the Femur

A satisfactory treatment for most of these cases is fixation with the Smith-Petersen nail after the fracture is accurately reduced. Traction rolling the leg inward, and abduction are usually sufficient for reduction, but Ledbetter's method may be necessary to disengage the fragments. When the position is satisfactory as determined by anteroposterior and lateral X ray pictures the patella is rolled inward 20 so that the neck of the femur is horizontal. An incision is made about 5 cm. long starting at the greater trochanter and extending downward parallel to the femur A Kirschner wire is introduced about 8 cm. into the neck of the femur using a special drill with an extension brace to steady the wire. The wire should enter the femur 2 cm. below the greater trochanter and its course should be parallel to the surface of the operating table with the point directed toward the junction of the inguinal ligament and the femoral artery which lies over the head of the femur (Figure 227A) A measuring rod should be placed near the hip while an anteroposterior X ray exposure is made, after which the measuring rod is removed and a lateral view is taken. These films are immediately developed and the position of the Kirschner wire is determined. If the position is not satisfactory it



FIG. 237 *Insertion of Smith-Petersen Nail.* A. A Kirschner wire has been inserted by the method described in the text and its position checked by X ray The nail is about to be driven into the bone. B Nail in proper position.

is left in place and one or more additional wires are put in and checked by X ray A nail is selected, by comparison with the measuring rod, of such length that it will correspond to the distance between the surface of the femur and .5 cm. proximal to the femoral head. This is threaded on the wire which is in suitable position, and driven in until it reaches

the center of the head (Figure 227B) The time the nail reaches the head can usually be determined by the increase in resistance. The wire is removed and the nail is finally driven in until its point is about .5 cm. from the articular surface. To drive the nail in if the special instrument designed for the purpose is not available a piece of gas pipe longer than the Kirschner wire works very satisfactorily With the wire in the lumen of the pipe, it is a simple matter to drive the nail in by pounding on the pipe. Some surgeons prefer to make a longer incision and introduce the hand along the neck of the femur so that more accurate visualization of the position of the neck can be obtained. The wound is closed by the usual method, and a short spica cast is applied, to be left on for three weeks. No weight bearing is permitted for several months. It is not necessary to remove the nail but if desired it may be taken out at any time after six months. For this purpose the extractor[1] designed by White is convenient.

Skeletal Traction

Traction obtained by pull directly on the bones is more certain and more comfortable than skin traction. There is a potential danger of infection taking place in the bone, but this slight risk is counterbalanced by the advantages of the method. Of the three methods of skeletal traction the Kirschner wire, the Steinman pin, and ice tongs, the Kirschner wire is most generally used. The skin at the point selected for the introduction of the wire is sterilized as much as possible, the skin is drawn slightly upward, and with a special drill the wire is introduced through the bone and out the other side. The drill is removed, the wire is fitted into a bow that will hold it taut, and traction is applied to the bow

Fracture of the Spine

The primary purpose of operation here is to relieve pressure on the spinal cord by decompressing it and to remove any small fragments of bone that impinge on it. The decision to operate is based on the presence of increasing neurologic symptoms plus evidence of spinal block as shown by the Queckenstedt test. Neurologic examination will determine the level of the lesion, and X ray study may show narrowing of the canal by a deformed vertebral body or by a fragment of bone To be effective operation must be performed not later than forty-eight hours after the development of the paralysis.

Technique of Laminectomy

An incision (Figure 228) is made that is centered at the level of the injury and extends two or three spinous processes above and below The

1. Made by Zimmer Mfg Co Warsaw Indiana.

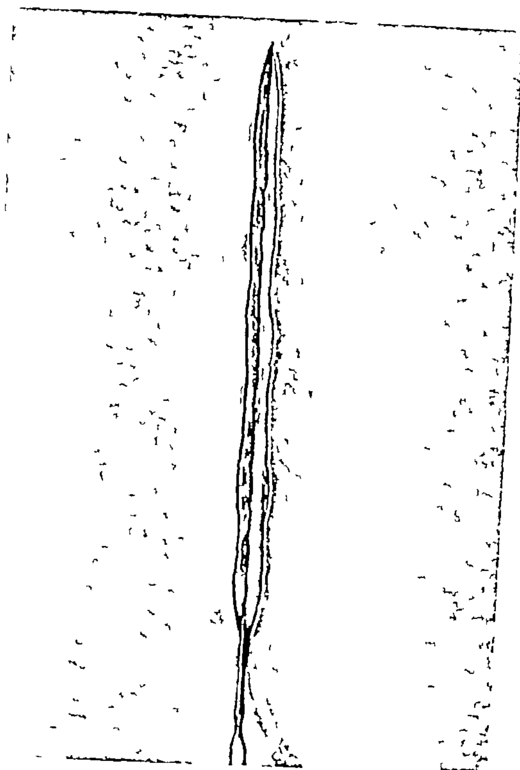


FIG. 228 *Laminectomy* Incision.

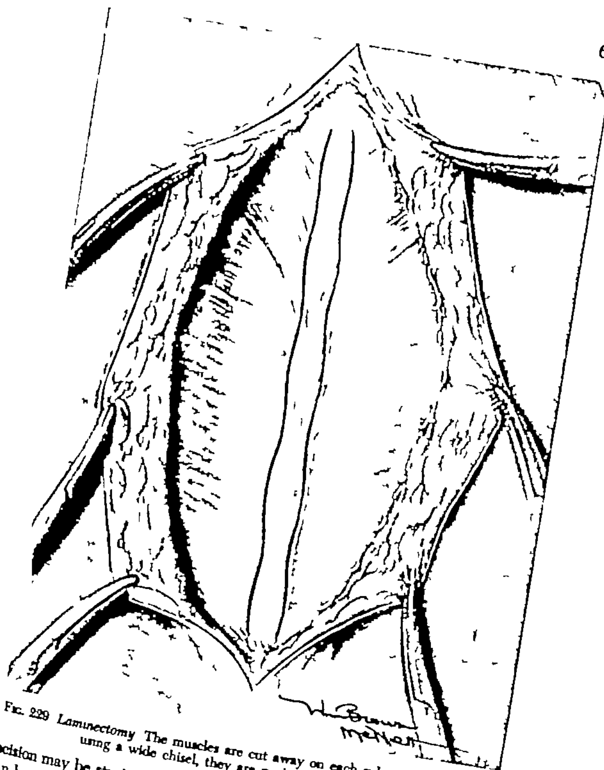
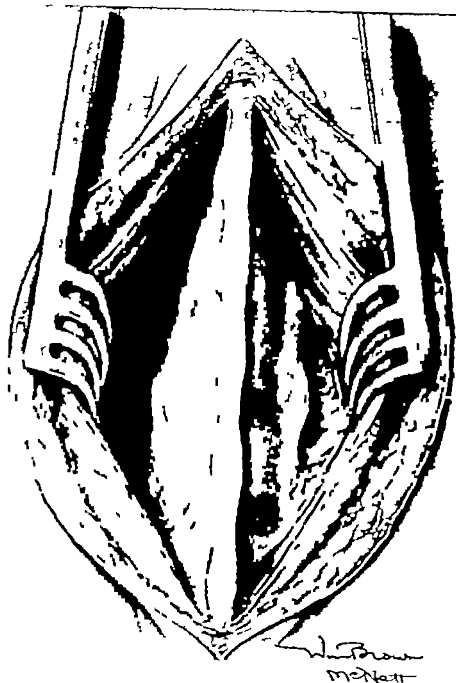


FIG. 229 *Laminectomy* The muscles are cut away on each side of the spine, and using a wide chisel, they are pushed off the laminae

incision may be straight, or may have a slight curve so that a flap of skin can be raised from the spinous processes and the scar will not be left in the midline. With a wide chisel, the muscles are separated subperiosteally from the spinous processes and from the laminae (Figure 229) The separation is completed first on one side and the profuse bleeding that occurs is controlled by packing the space tightly with gauze while the operation



30 *Laminectomy* The laminae are exposed and a self-retaining retractor has been inserted.

inued on the other side. A self retaining retractor is now inserted the muscles apart (Figure 230) the interspinous ligaments are cut knife between the spines to be removed, and the spinous processes n cut off with bone forceps. Rongeur forceps are now used to re- he laminae, with care that any prying motion made is away from nal canal and not toward it. If an extradural clot is present, or if

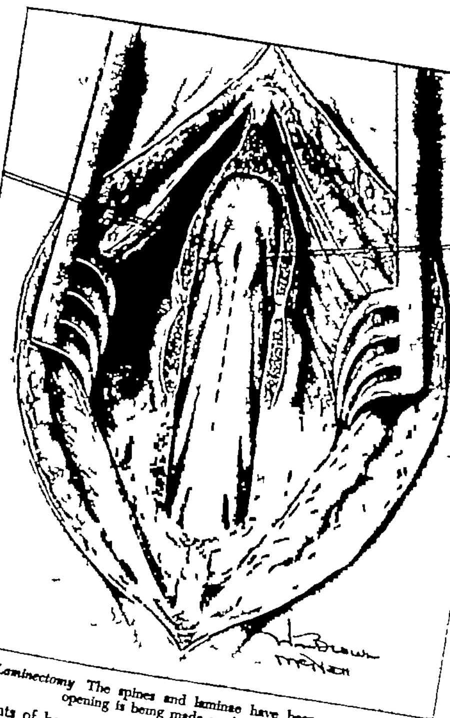


FIG. 231. *Laminectomy* The spines and laminae have been removed and an opening is being made in the dura.

any fragments of bone are seen, they should be removed. The dura is picked up on a small hook or with fine toothed forceps, and opened in the midline (Figure 231) and a silk suture is placed on each side of the dural incision for traction. The cord should be inspected and any intra dural clots should be removed. The edges of the dural incision are now brought together by interrupted sutures of fine silk. Deep interrupted sutures of catgut are used to approximate the muscles, and the fascia is sutured with a continuous or interrupted suture of catgut. The skin is closed with dermal.

Fracture of the Skull

Compound Fracture The scalp is shaved and the wound is carefully cleansed with soap and water after which the skin is painted with an antiseptic. Fragments of bone or foreign bodies should be washed out with sterile normal saline solution. If necessary the wound is enlarged, and if the edges of the skin are macerated the injured portion is trimmed off If the dura is torn, the edematous brain bulges into the wound. If there is a penetrating wound evident in the brain, a catheter should be introduced gently and the tract irrigated with salt solution. If a foreign body is felt and cannot be washed out, it should be removed with forceps, but no extensive exploration of the brain should be undertaken in the presence of infective organisms. The dura should not be closed unless this can be done without tension. The galea and scalp are closed by interrupted sutures of silk.

In cases of compound fracture seen after infection has already set in, or those in which the laceration is so extensive as to make closure impossible or in which herniation of the brain has occurred through the torn dura, the scalp is closed loosely with interrupted silk sutures. Brain fungus caused by edema of the brain is apt to occur and will not subside until the edema and infection have been overcome. The fungus is protected by rubber tissue, covered by a dressing, and may require six weeks or longer to subside

Depressed Fractures· A flap of scalp is turned down over the area of the fracture the base of the flap pointing toward the base of the skull. If multiple loose fragments are present, they should be removed and the larger ones washed with normal saline solution and replaced. If the fragments of bone are depressed and cannot be lifted by the simple insertion of a sharp instrument into the fracture line and prying outward, a burr hole should be made near the depressed area, and through this a slightly curved periosteal elevator is introduced and used to push the fragment out. The dura should not be opened, but if it is torn the edges may be lifted up and the brain inspected. Any torn cortical vessels should be clipped or coagulated, and if there is an area of the brain that is definitely softened or macerated, it should be removed by suction or excision Blood, foreign matter or bone if seen on the brain should be washed out by irrigating the region with normal saline solution. A catheter may be gently introduced under the dura in various directions while the irrigating is continued. The dura should be repaired unless the brain is under such tension from edema that this is impossible. The galea and skin are closed separately by interrupted sutures of silk placed about 1 cm. apart.

Fractures Associated with Injury of the Middle Meningeal Artery· The middle meningeal artery runs on the outer surface of the dura, and when the fracture line extends across its course the vesse equently torn

and blood extravasates between the dura and the skull (epidural hemorrhage), producing the signs of intracranial pressure Subtemporal decompression should be performed to remove the blood and ligate the bleeding vessel.

Technique of Subtemporal Decompression The operation can be done under local anesthesia The patient is placed on his back with the head

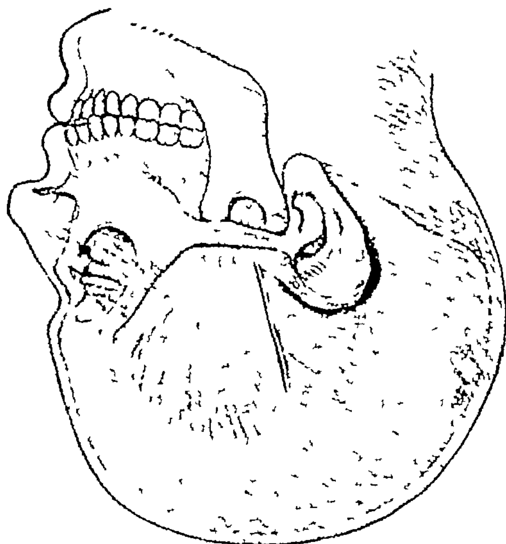


Fig 232 *Subtemporal Decompression* Incision.

turned to the sound side and elevated somewhat on a sandbag After the field is draped off an incision is made that begins about 6 cm. above the ear and extends downward and forward to the zygoma, passing about 1 cm. in front of the ear (Figure 232) The incision is deepened through

the temporal muscle down to the skull and the scalp and muscle are retracted and held apart by the insertion of Jansen mastoid retractors in upper and lower margins of the wound. At the middle point of the incision an opening is made in the skull with a perforator and this is enlarged by

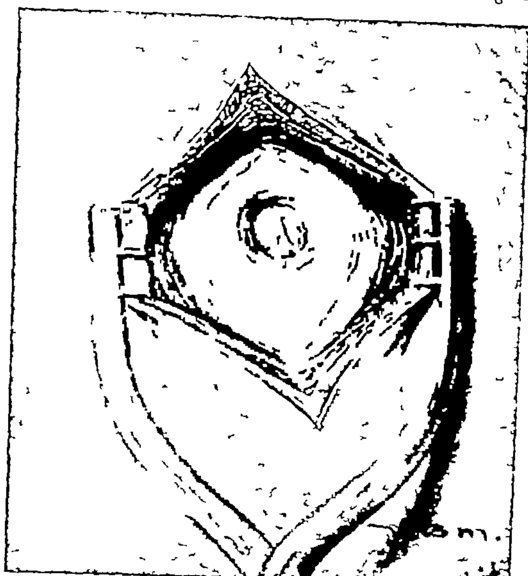


FIG. 233 *Subtemporal Decompression.* An opening made in the temporal bone with a perforator has been enlarged with a burr

a Hudson burr (Figure 233) As soon as the bone is penetrated, blood that has escaped from the wounded vessel should be seen. A periosteal elevator is introduced through the burr hole, and the dura is separated from the skull around the opening With rongeur forceps, the burr hole is enlarged peripherally until an opening 3 cm. or more in diameter is obtained (Figure 234) The epidural clot is removed by suction and by washing with normal saline solution. The middle meningeal artery which passes across the dura in the middle of the field, is followed downward

and ligated below the injured point The most satisfactory way to ligate the vessel is by using silk on a small curved needle, but it may be clamped with a silver clip or coagulated with the electrosurgical current. If there is any bleeding from the edges of the bone, this is controlled by

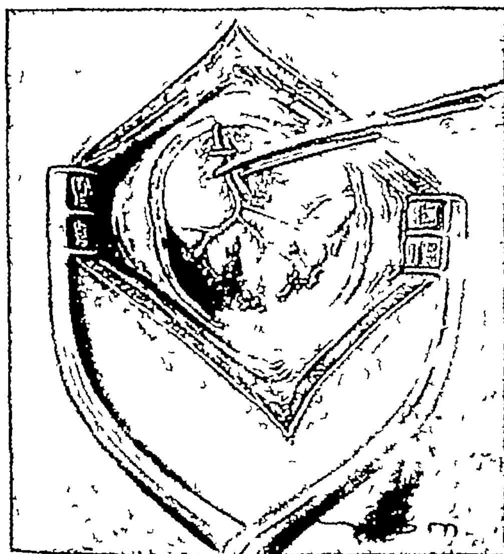


FIG. 234. *Subtemporal Decompression*. The opening in the bone has been en larged with rongeur forceps The epidural hemorrhage is visible and clips are being applied to the middle meningeal artery

bone wax. The retractors are removed and the split temporal muscle is brought together by interrupted sutures of silk followed by similar sutures in the skin.

DEFORMITY OF BONE

Occasionally angulation of the shaft of a long bone may require cor rection by osteotomy There are two types of osteotomy in common use the linear osteotomy and the wedge osteotomy the former having the ad

vantage that it entails less danger of the bone ends getting out of position. For knock knees the operation is done just above the femoral condyles or in the upper end of the tibia, and this is also true for bow legs. The osteotomy should be done where the curve of the leg is apparently greatest. In malunited fractures, the location of the osteotomy will of course depend on the location and angulation of the malunion. An incision is made down to the bone, and to do linear osteotomy (Figure 225A) an osteotome is driven transversely almost through the bone with a hammer or a similar cut is made with a saw The bone is then broken by hand so that the periosteum on the opposite side will be intact, the muscle and skin are closed, and a cast is applied with the limb in proper alignment. In performing a wedge osteotomy (Figure 225B) the bone is exposed and a wedge shaped piece is removed with an osteotome or saw The apex of the wedge should be near enough to the opposite side of the bone so that the bone can be broken manually

TUMORS OF THE BONE

Benign Tumors

Osteoma Bony outgrowths may arise from the surface of a bone, when they are known as exostoses. Growths arising in the center of a bone, usually the skull or the bones of the face, are known as enostoses. The most common site for exostoses are the ends of the long bones. The tumors are often multiple, and may be hereditary and associated with abnormalities of bone growth. Osteomata are usually hard and cauliflower like in shape, and are sometimes attached to the bone by a narrow pedicle.

Chondroma Tumors composed of cartilage are most commonly found in the hands and feet, but the growths may develop near the ends of long bones or on the pelvis, scapula, ribs, or skull. The surface of the tumor is lobulated, and it is encapsulated and can usually be easily shelled out. Calcification, ossification, and cystic degeneration are common. Growth of the tumor usually stops when bodily growth is completed.

Bone Cyst Benign cyst of the bone is usually seen in children and is most frequently located in the upper end of the shaft of the humerus, tibia, or femur There is a central defect of the shaft of the bone, with thinning out and expansion of the cortex to produce a fusiform swelling Pathologic fracture is common through such a cyst and may be the first symptom to call attention to the tumor

Giant-Cell Tumor This tumor is most often found in the ends of the long bones but may occur in the jaw or other bones, or even in a bursa, the capsule of the joint, or a tendon sheath. The giant-cell tumor of the jaw is known as an epulis. Regardless of its location the tumor is red

dish in color and very soft in consistency and its growth causes absorption of the bone so that only a shell may remain. A blood filled cyst is often seen in the center of the tumor

Treatment of Benign Tumor of the Bone The tumors described above osteoma, chondroma, bone cyst and giant-cell tumor are all benign and their treatment may be conveniently considered under one heading The diagnosis in these cases is made by the X ray findings the age of the patient, and the location of the tumor and biopsy of the bone is rarely necessary Osteoma causing pain or deformity may be removed by making an incision down to the bone and removing the tumor with a chisel. Since the chondroma tends to stop growing as the patient gets older treatment should be postponed if possible until the patient is past the age of twenty one. If it is necessary to remove the tumor because of deformity good bone around the tumor will have to be sacrificed, and this may cause considerable weakening of the shaft of the bone Occasionally a chondroma not completely removed may apparently undergo malignant change and metastasize, so that unless one is prepared to sacrifice the shaft of the bone when indicated, surgery should be avoided. Radiotherapy is of little value in the treatment of this tumor Bone cyst and giant-cell tumor should be treated by curettement of the bone In the case of the cyst, the lining should be removed, and it is well to place bone chips obtained from the tibia in the cavity to hasten bone production. If a pathologic fracture is due to a bone cyst, often simple splinting of the fracture will result not only in healing of the bone but disappearance of the cyst. In pathologic fracture due to giant-cell tumor the bone should be exposed, the tumor curetted out, and if necessary the fracture held in reduction by drilling one or two holes in each fragment and tying them together with chromic catgut.

Malignant Tumors

Osteogenic Sarcoma This is a not uncommon and most malignant tumor which grows rapidly and metastasizes by way of the blood stream or sometimes by lymph vessels and secondary invasion of the lungs is very common. The end of the shaft of a long bone, particularly the lower end of the femur and the upper end of the tibia, is the site of election. The tumor produces a fusiform swelling of the shaft of the bone, and the cortex, medulla, and periosteum are all involved. Radiating spicules of bone cartilage and areas of cystic degeneration and hemorrhage are seen on the surface

Ewing's Tumor The majority of cases of this tumor occur between the ages of 5 and 15 and over 80 per cent are found in patients under 30 The tumor is usually located in the humerus, tibia, femur fibula, or clavicle, but small bones, particularly the calcaneous may be affected.

The growth begins in the medullary cavity and, having destroyed the shaft of the bone it invades the surrounding tissues. It is very soft in consistency so much so that it may be like jelly and may be so diffuse as to involve the entire bone. Metastasis to other bones is common, and secondary nodules may be found in the lungs or other organs. The disease is often mistaken for osteomyelitis because of its roentgenographic appearance, and, if an incision is made into the tumor yellowish tumor tissue that resembles pus may be exuded and add to the confusion.

Multiple Myeloma The disease is characterized by multiple tumors, which begin in the bone marrow and may involve the ribs, sternum, vertebrae, skull, clavicle, pelvic bones, and long bones of the arms and legs. The bone marrow becomes replaced by a grayish or reddish mass, and the cortex of the bone is thinned so that pathologic fractures are common. Metastasis to the liver and spleen may take place. A peculiar feature of the disease in considerably over half of the cases is the presence in the urine of the Bence-Jones protein.

Secondary Carcinoma Metastatic tumors of the bone are common the primary tumor usually being in the prostate, kidney, breast, or thyroid. The bones most frequently involved are the vertebrae skull, sternum, pelvis femur and humerus The bone lesions are destructive in character except in the case of some tumors originating in the prostate, which show new bone formation. Pathologic fractures are very common.

Treatment of Malignant Bone Tumors The prognosis is poor in osteogenic sarcoma, regardless of the type of treatment used. If the involved bone is not weight bearing it should be removed if possible. The fibula radius, ulna, clavicle, or a rib can thus be excised. In the case of the humerus, femur or tibia, after biopsy in adults amputation is indicated, in children X ray Ewing s tumor should be treated first by deep X ray therapy and the rapid decrease in the size of the tumor is confirmatory evidence of the nature of the tumor When the maximum effect of radiation has been obtained, removal of the involved bone should be done if possible and if not amputation should be done The prognosis for the patient with this tumor is not good, but it is better than in the case of osteogenic sarcoma. If amputation cannot be done, the patient should be treated from time to time by X ray

Multiple myeloma should be treated by X ray with the expectation of reducing the pain and prolonging life but the condition is uniformly fatal

Secondary carcinoma of the bone is another hopeless condition, but X ray treatments may control the pain in some cases, and there is some evidence that in the male castration may temporarily arrest or cause retrogression of the bone lesions, particularly when the primary tumor is in the prostate

OSTEOMYELITIS

Acute Osteomyelitis

The bones that are most frequently involved are the tibia femur hu merus, radius, ulna, and fibula, and infection usually begins in the metaphysis, with pus formed under pressure The infection may extend into the medullary cavity or through the cortex and in the latter case the periosteum is raised away from the bone Such a subperiosteal abscess may rupture into the soft tissues and burrow to form a subcutaneous abscess, which in turn may rupture to the outside in the form of a drain ing sinus. The infection of the bone causes more or less necrosis the ex tent of which may not be recognized until several weeks later At this time the dead bone becomes separated from the shaft in the form of a sequestrum, and new bone formation (involucrum) takes the place of that which is destroyed.

Acute osteomyelitis should be treated by penicillin and sulfonamides. During this period of treatment dehydration should be combatted and transfusions should be given for anæmia and sepsis. If in spite of this ther apy surgery becomes necessary, there should be as little destruction of the bone as possible. The infected part of the bone should be exposed and several holes drilled, usually into the cancellous bone of the metaphysis near the epithyseal line The periosteum at operation may be found to be elevated by pus, and when this occurs the medullary canal is apt also to be involved, but the latter should not be perforated unless there is evidence that the infection has extended to it. Enough drill holes should be made to assure good drainage the wound should be loosely packed with petrolatum gauze and a cast applied to the extremity About three months after the acute infection, when a sequestrum has formed, it should be removed, since it acts as a foreign body in prolonging the infection but the sequestrum should not be taken out until the involucrum is strong enough to support the limb. In order to remove the sequestrum, sufficient bone must be unroofed to approach it, and the involucrum should be saucerized with a chisel so that the cavity will be filled by muscle. The wound should be packed loosely with vaseline gauze and a cast applied. The wound is not re-dressed for a considerable period, unless febrile re action points to extension of the infection Usually the dressing can be left in place for two weeks or longer at a time Sulfonamide drugs and peni cillin should be used in the treatment of the disease but reliance cannot be placed on them alone

Chronic Osteomyelitis

In cases of chronic osteomyelitis the infection has become less viru lent, but draining sinuses are commonly present and there is usually

considerable deformity of the bone, with areas of rarefaction, destruction, and increased density Small pieces of bone may be discharged from the sinuses and a large sequestrum may be present. The treatment here consists of removal of sequestra and unroofing of sufficient bone to drain residual abscesses. Drill holes are made about 1 cm. apart in such a way as to outline a window throughout the length of the diseased bone. The window is removed with a chisel, and the overhanging edges of bone are cut off If a sequestrum is present it should be removed, and the involucrum should be saucerized so that the soft tissues can obliterate the space. The wound is packed open with vaseline gauze, and a cast is applied. After healing of the wound is complete except for the growth of skin, a full thickness graft applied to the clean granulations may hasten the process.

Brodie's Abscess

This is a low-grade localized abscess of the bone, which is usually located in the tibia, the upper or lower end of the femur or the end of the humerus. The abscess is limited by a fibrous membrane, but the surrounding bone may become thickened or deformed. Operation should be performed to unroof the cavity and it should be packed with vaseline gauze

ACUTE SUPPURATIVE ARTHRITIS

The Shoulder The shoulder joint may be aspirated by inserting a needle below the tip of the acromion process of the scapula. To drain the joint a vertical incision is made through the deltoid muscle between the coracoid and acromion processes.

The Elbow A needle may be introduced from the posterior surface into the space between the lateral condyle and the olecranon, or from the lateral side just proximal to the head of the radius. For drainage of the elbow joint, bilateral epicondylar incisions may be made using care to avoid the ulnar nerve on the medial side A single incision along the lateral side of the olecranon may also be used

The Wrist Aspiration may be performed by inserting a needle into the joint between the extensor carpi ulnaris and flexor carpi ulnaris tendons just beyond the styloid process of the ulna or between the extensor pollicis longus and the extensor indicis proprius just distal to the end of the radius To open the joint, a vertical incision may be made on the dorsum of the wrist between the *extensor pollicis longus* and the extensor indicis proprius.

The Hip To aspirate the joint the needle is introduced anteriorly 2.5 cm. lateral to the midpoint between the anterior superior spine and the symphysis pubis. The femoral artery which should be 2.5 cm. medial to this point should be palpated and avoided. The joint may be ap-

proached by the method of Langenbeck. An incision is made from the middle of the greater trochanter obliquely upward toward the posterior superior spine of the ilium. The gluteus maximus is split and retracted exposing the gluteus medius and pyriformis muscles. When these muscles are separated, the posterior surface of the hip-joint capsule is exposed. The sciatic nerve, which lies medial to the incision, should be avoided.

The Knee The needle may be inserted either lateral or medial to the patella, and the joint may be exposed through a vertical incision made in either of these regions.

The Ankle The joint may be aspirated just in front of either the external or the internal malleolus, and an incision may be made at either of these locations.

Penicillin and sulfonamides are of prime importance in the treatment.

DISLOCATION AND INJURY OF THE SEMILUNAR CARTILAGE

The internal meniscus is injured about ten times as frequently as the external. When removal of the cartilage is indicated, operation is best performed with the leg hanging over the end of the operating table the knee being flexed at 90° To remove the internal semilunar cartilage, the medial incision indicated in Figure 235 may be employed. For more extensive exposure the Jones incision is commonly used. This begins 2.5 cm. medial to the upper end of the patella, passes downward parallel to the patella and patellar tendon about 5 cm., and then curves posteriorly for 3 or 4 cm. After incision of the skin, the deep fascia and capsule are incised 1 cm. medial to the skin incision to reduce the danger of communication between the joint and the outside. The opening in the synovial membrane is enlarged to the width of the skin incision. The cartilage is inspected, bringing various parts of it into view by manipulating the knee. The cartilage is grasped with a hemostat and cut loose along its periphery beginning in the anterior region and working backward. Care should be used not to injure the articular cartilage of the joint. The joint capsule is then closed with a continuous suture of fine chromic catgut the subcutaneous tissue is closed with a similar suture and the skin is closed with dermal. Usually all of the cartilage can be removed by this approach, but sometimes to remove the posterior segment, the posterior incision of Henderson is used. In this approach the knee is flexed and an incision 7.5 cm. long is made on the posterior aspect just in front of the semi membranosus, semi-tendonosus, gracilis, and sartorius. After incision of the fascia and capsule, the synovium is opened and the posterior compartment is exposed.

Removal of the external semilunar cartilage is done by incisions corresponding to those described for the internal cartilage, but on the lateral side. In the posterior approach, the incision is made medial to the biceps tendon.

A posterior splint is applied but this is removed after the fourth day to permit active movement of the joint. The patient is allowed to walk on the tenth day



FIG. 235. *Incisions for Operation on Internal and External Semilunar Cartilages.*

PROTRUDED INTERVERTEBRAL DISC

Protrusion of the nucleus pulposus takes place most commonly between the fourth and fifth lumbar vertebrae, or between the fifth lumbar vertebra and the sacrum, but any joint in the spinal column may be involved. A dorsal midline incision is made with its center at the affected level. If the protruded nucleus is in the usual location the first spine of



FIG. 236. Removal of Protruded Intervertebral Disc. The laminae have been exposed as in laminectomy and the lower portion of a lamina has been cut off near the spine with rongeur forceps. The nerve root has been retracted and a cruciate incision has been made in the capsule

the sacrum is identified and, with the use of a chisel as described under laminectomy (page 605) the muscles are stripped back on each side of the spines of the fourth and fifth lumbar vertebrae as far as the articular processes of the laminae A self retaining retractor is inserted, and any bleeding vessels are controlled by ligation or by the coagulating current

With the use of narrow rongeur forceps a portion of the lower margin of the lamina of the fifth lumbar vertebra is removed as close to the spinous process as possible The ligamentum flavum which is partly covered by the lamina and which itself is sometimes so hypertrophied as to cause

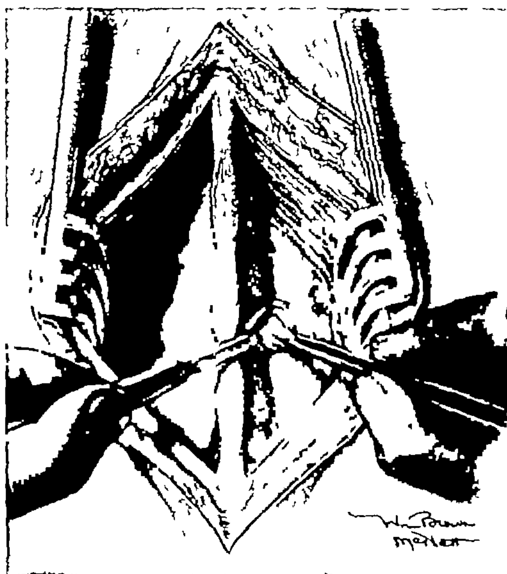


Fig. 237 *Removal of Protruded Intervertebral Disc* The extruded nucleus is being removed

pressure on the nerve root, is cut off near the midline with a sharp knife, and carefully turned back laterally like a trapdoor and cut off thus exposing the nerve root and the protruded disc. The dura lies medial to this region and is not opened. If troublesome bleeding is encountered from the extradural veins, it can be controlled by electrocoagulation or by holding a piece of muscle over the area The nerve root is carefully pulled aside with a small blunt retractor an incision is made in the thinned-out

ligament that covers the nucleus (Figure 236) and the dislocated portion of the disc is removed with a hemostat (Figure 237) If the nucleus is not sufficiently loose to come out freely it is necessary to introduce a bone curette between the bodies of the vertebrae and scrape it out, but care should be used not to allow the curette to protrude anteriorly beyond the vertebral body If no abnormality is found in the disc first explored, it is necessary to explore the next one or two above it. At the conclusion of the operation the muscles are brought together by a few interrupted sutures, a continuous suture of catgut is used to close the fascia, and the skin is sutured with dermal

TUBERCULOSIS

Tuberculosis of the Spine

In these cases, there is early destruction of the intervertebral disc, and later destruction of the body of the vertebra with collapse of the body and kyphosis of the spine Abscesses are common and when they arise from the lower dorsal or lumbar spine they may extend along the psoas muscle and pass under the inguinal ligament to point in the femoral triangle Prolonged immobilization of the spine is necessary and in many cases a fusion operation is indicated

The Albee method of fusion is performed as follows A longitudinal curved incision is made over the involved area of the spine and the interspinous ligaments are split longitudinally The spinous processes are split by an osteotome to a depth of about 3 cm and one side is fractured laterally near its base to permit the introduction of a graft. A bone graft is obtained from the tibia, using a circular saw or cutting it out with a chisel between drill holes. The graft should be about 2 cm. wide and should be long enough to extend over the length of the bed that has been prepared — this should include at least one normal vertebra above and below the lesion. When there is considerable curvature of the spine, the pattern of the curve should be taken with a piece of soft metal and a similar curve made in the graft by outlining the pattern on the surface of the tibia before cutting it. The graft is placed between the split spinous processes and held in place by interrupted sutures of catgut. The ligaments and fascia are sutured over the graft and the skin is closed with dermal. The patient should be kept on his back on a fracture bed for six weeks.

Tuberculosis of the Hip

The joint may be immobilized by a plaster cast, or arthrodesis of the hip may be performed. Conservative measures should be tried first, since a fused hip joint is not as satisfactory functionally as a fused knee joint.

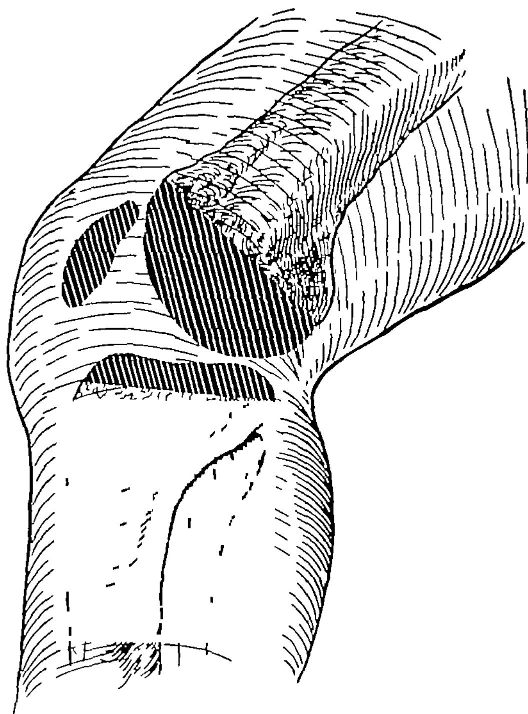


FIG. 238 *Arthrodesis of the Knee* The shaded area shows the portion of bone to be removed.

Tuberculosis of the Knee

Arthrodesis of the knee joint for tuberculosis is performed by making a liberal U shaped incision the transverse portion of which is just above the tuberosity of the tibia The patellar tendon is cut transversely the capsule of the knee joint is opened and the ends of the bone are exposed by flexing the knee Since tuberculosis often involves the synovial membrane underneath the quadriceps muscle this pouch is carefully dissected out. The joint capsule is excised, and in the posterior part of the joint the popliteal artery should be guarded The cruciate ligaments are cut, and then with a saw the femur is sectioned below the upper level of the trochlear surface keeping the line of section parallel to the joint line. The lower end of the tibia about 1 cm. from the articular surface is now sawed off (Figure 238) The patella is removed and sawed so as to leave a raw bone surface on three sides, after which it is embedded in a groove made in the anterior surface of the femur and tibia across the line of resection. The fascia and skin are closed and sutured, and a cast is applied and left on at least six weeks. In children because of the danger of interfering with growth of the bone, a more conservative operation should be done The articular cartilage should be cut off and only diseased portions of the bone removed.

HALLUX VALGUS

Enlargement of the distal end of the first metatarsal with outward deviation of the great toe (bunion) may be corrected by the type of arthroplasty devised by C. H Mayo A curved incision with the convexity upward is made over the joint and the skin is dissected downward. A flap of the tissues overlying the head of the bone including the bursa, is now turned distally (Figure 239A) exposing the bone and the head of the bone with the exostoses is removed with a bone biter By interrupted sutures the bursal flap is fastened into the depths of the joint between the cut end of bone and the phalanx (Figure 239B and C) The skin flap is turned up and closed with dermal. A median splint made of a tongue depressor is applied to hold the great toe in alignment. After ten days motion is begun.

RECURRING DISLOCATION OF THE SHOULDER

Henderson s method of correction consists of making a curved incision in such a way as to turn up a flap of skin from the shoulder in the region of the head of the humerus and the acromion process. The deltoid muscle is separated in front and behind the humeral head, and a large drill hole is made through the greater tubercle. The end of the acromion process

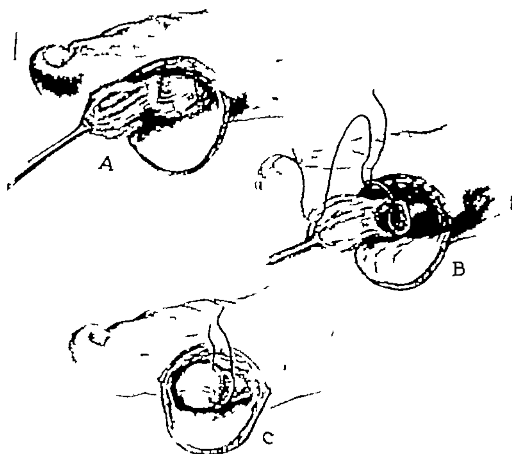


FIG. 239 *Mayo Operation for Hallux Valgus.* A An incision with its convexity upward has been made through the skin and subcutaneous tissues and the flap has been turned down. Tissue over the head of the bone including the bursa has been cut loose and pulled distally. The dotted line shows the portion of the metatarsal to be removed. B The bursal flap is being sutured deep in the joint so that the raw end of bone will rest against it. C. Further sutures are being placed to hold the tissue in position

is exposed, and a similar drill hole is made through it transversely The tendon of the peroneus longus is exposed and split longitudinally so that one half of it can be removed. The wound in the leg is closed, and the piece of tendon is threaded through the hole in the acromion process and in the tubercle of the humerus after which the ends are fastened together with silk (Figure 240) The incision is closed and a Velpeau bandage is applied to immobilize the arm for two weeks, after which motion is begun.



FIG. 240. *Henderson Method of Correcting Recurring Dislocation of the Shoulder* A flap of skin and subcutaneous tissue has been turned up, and through slits in the deltoid muscle a hole has been bored through the acromion process and through the greater tubercle. A piece of peroneus longus tendon has been threaded through the holes and will be sutured in place.

POSTOPERATIVE CARE

A fracture bed, Bradford frame or other necessary apparatus should be ready when the patient is returned to his room. A recently applied cast should be supported by pillows and not allowed to rest on any hard surface until it is dry Electric lights may be used to hasten the drying Shock, dehydration, or pain are treated as described for other surgical cases. If there is infection or potential infection, penicillin is usually indicated. When a circular cast has been applied, the extremity should be kept under careful observation for evidence of impairment of the circula

tion as shown by pain numbness, swelling, blanching, or cyan the circulation is interfered with, the cast and all circular dressings be immediately cut. The cast is bivalved and reapplied more loose two sections being held together by adhesive plaster Attendants be on the alert to prevent bed sores, by turning the patient freq when possible by scrupulous cleanliness of the skin and by the rubber rings or pads as indicated. Physiotherapy should be star early as possible beginning with massage and passive motion. The should never be carried to the point of causing the patient severe Active motion is gradually started and the patient is got up into a chair or on crutches as soon as the condition of the bone permits reduction of a fracture a postoperative roentgenogram should alw taken, and X ray studies should be made later at any time when t concern about the accuracy or degree of union.

CHAPTER XXVIII

The Blood Vessels

The Blood Vessels

With the availability of Heparin and Dicumarol as agents to reduce the danger of intravascular thrombosis, surgery of the blood vessels is finding an increasing field of practical application. The potent effect of these drugs makes it necessary however to use them with extreme caution and in a properly selected group of patients.

PREOPERATIVE PREPARATION

The usual general preoperative measures used in other surgical operations are indicated when an operation is to be done on the blood vessels. For a procedure such as the removal of an embolus from an artery there may be no time for extensive preparation, and for ligation of the femoral vein under local anesthesia or other short operations, no special preparation may be necessary Before operative treatment of varicose veins, edema and infection should be treated by putting the patient to bed and elevating the extremity

LESIONS OF THE BLOOD VESSELS AND THEIR TREATMENT

Embolism

The sudden onset of severe pain in an extremity associated with coldness and pallor marks the onset of what is one of the most distressing complications of surgery and one of the most serious manifestations of a clot in the pulmonary vein or in the left side of the heart. If the collateral circulation is insufficient, gangrene of the extremity will take place unless the embolus can be removed. After the lodgment of an embolus, thrombosis commonly takes place in the vessel in a proximal direction from the embolus to the first major branch. Fortunately the thrombus thus formed attaches itself to the embolus and simplifies somewhat the problem of removing it. The point of lodgment of an embolus in an extremity can be determined with fair accuracy by determining the level at which pulsa

tion of the vessel ceases. If the lower extremity is involved and no pulsation can be felt in the femoral artery one may assume that the thrombus extends up into the region of the common iliac artery A thrombus located a little higher at the bifurcation of the abdominal aorta, produces symptoms in both extremities by obstructing both iliac vessels. If the embolus is accessible, it should be removed preferably within three hours after onset. Cerebral embolism and embolism of the coronary arteries are beyond the scope of surgery but pulmonary embolism has been treated successfully in a few cases. Massive pulmonary embolism is invariably fatal, and the duration of life after onset is said to average one half hour, but many patients with less extensive embolism recover The operation is one of considerable magnitude and high mortality and entails opening the pulmonary artery and removal of the embolus or as has been recently suggested, the passage of a catheter through an incision in the right ventricle up into the right auricle, and thence into the pulmonary artery to remove the embolus by suction. Special instruments must be selected and kept sterilized for such an emergency and a skilful surgeon and a surgical crew must be available within a few minutes. The patient must be seen and examined and a decision made whether or not the embolism will be fatal unless operation is performed, and the actual operation must be done within the extremely limited time available. The average survival time is given as one-half hour but many patients die within five minutes. All these difficulties make the surgical treatment of pulmonary embolism practically impossible for the private practitioner of surgery and limit its use to large institutions, where the condition may be seen relatively often and where the responsibility for diagnosis and operation can be placed on the resident surgeon.

Embolectomy performed on any artery whether pulmonary or peripheral unfortunately leaves the source of the embolus undisturbed, and subsequent emboli occur in at least half the cases.

Arteriovenous Fistula

The acquired type of arteriovenous fistula is usually caused by a perforating injury in which the walls of a neighboring artery and vein are penetrated. Arterial blood finds its way from the artery into the vein and causes dilatation and tortuosity of the latter In many instances, the wall of the vein may not be penetrated at the time but a fistula occurs by erosion of the vein. A pronounced thrill and bruit are present, together with evidence of general circulatory embarrassment.

The congenital type of arteriovenous fistula produces extreme enlargement of the neighboring veins, and the radiating snake-like vessels associated often with dilatation of the vein and artery have caused it to be known as cirsoid aneurysm. Surgical treatment of the condition is not often possible because of the enormous mass of dilated vessels that are

encountered, the ligation of which may be attended with gangrene of the extremity

The usual procedure in the treatment of acquired arteriovenous fistula is quadruple ligation with excision. This means dissecting out the communicating artery and vein, ligation and division of both vessels above and below the fistula, similar ligation and division of all communicating vessels, and excision of the sac. When an artery communicates with two veins, a similar procedure is done but in this case it consists of sextuple ligation and excision. These operations require permanent interruption of the artery and will be followed by evidence of vascular insufficiency if the collateral circulation is inadequate.

When the blood flow through the region of the fistula can be controlled by a proximal constrictor it may be possible to perform transvenous arteriorrhaphy This procedure preserves the lumen of the artery and in the case of such vessels as the popliteal and the internal and common carotid arteries this may be a very important advantage. The operation cannot be done if there is pathologic change in the wall of the artery or if closure of the fistula would so narrow the lumen of the vessel as to interfere with the passage of blood. Recurrence of the fistula or thrombosis at the site of the operative procedure may take place, and when there are many communicating vessels it may be practically impossible to control the blood flow enough to do the operation The involved vein should be ligated above and below the fistula, and the involved segment excised except in so far as it is used to close the opening in the artery

Common locations for arteriovenous fistula are between the femoral artery and vein, the carotid artery and the jugular vein, the axillary artery and vein, and the internal carotid artery and cavernous sinus In the last condition, ligation of the internal carotid artery is often sufficient to relieve the symptoms.

Aneurysm

Dilatation of an artery may be due to trauma, disease of the artery or congenital weakness. Most aneurysms located in an artery of an extremity are traumatic in origin and most intrathoracic and abdominal aneurysms are due to syphilis. The fusiform or sacular swelling and the expansile pulsation are characteristic of the lesion.

When collateral circulation is sufficient and the aneurysm is accessible, the artery should be ligated above and below the lesion. For intracranial aneurysm ligation of the internal carotid may be helpful. Two other procedures have been used more or less for the treatment of aneurysm. In dealing with a thoracic aneurysm, ten feet or more of silver alloy wire which has been wound on a spool is introduced through a needle into the aneurysm, the wire coils up in the aneurysm sac, and after it is in place an electric current is passed through the wire to produce thrombosis in

the aneurysm. The wire is left in place in the aneurysm. I tried this on a few patients a number of years ago but was not convinced that the procedure influenced the course of the disease a great deal.

Aneurysmorrhaphy developed by Matas and which consists in opening the sac of an aneurysm re-establishing the lumen of the artery and imbricating the wall of the sac, may be considered when the artery cannot be ligated above and below

Varicose Veins

Enlargement and tortuosity of the veins of the lower extremity often produce pain or an aching sensation in the legs, and symptoms of inadequate circulation. Edema pigmentation eczema of the skin and sluggish ulcers are frequent complications and acute inflammation with redness and swelling is common. If the deep circulation is satisfactory and the valves of the communicating vessels are efficient the varicose veins may be treated by the injection of a sclerosing solution and, especially when the veins above the knee are dilated, this may be combined with high ligation of the saphenous vein. When the small saphenous vein is involved, it may be treated by simple injection or the vein may be ligated and then injected.

The superficial veins connect by a series of communicating veins with the deep vessels, the anterior and posterior tibial the peroneal and the popliteal veins. If the valves of these communicating veins are incompetent and permit blood to pass from the deep to the superficial veins, they should be exposed and ligated just under the deep fascia. The communicating veins may be divided into three groups each consisting of six or eight veins. The anterior group are located on the anterolateral surface of the leg, and anastomose with the great saphenous vein. The medial group are on the medial side of the leg and also connect with the great saphenous. The lateral group are located on the lateral and posterior surface, and anastomose with the small saphenous vein. Usually the medial group only is involved, but occasionally an additional group is affected, and rarely all three.

Thrombophlebitis and Phlebothrombosis

Thrombosis in a vein may be associated with changes in the vessel wall, and this condition, termed thrombophlebitis causes swelling of the extremity and evidence of infection, such as chills, fever and leukocytosis. Associated with this, there is commonly vasospasm of the arteries as shown by diminished pulsation. The condition may begin in the veins of the sole of the foot or the calf of the leg and extend upward, involving the deep veins and the femoral and iliac vessels, or may be primary in the femoral or iliac vein

In phlebothrombosis, on the other hand there is no change in the wall

of the vein, although a thrombus is present in the vessel. This condition begins in the plantar veins and the veins of the calf of the leg, but the clot may propagate far enough up to involve the external iliac vein, and, with involvement of the deep vessels, cyanosis and congestion of the subcutaneous veins are apt to be seen. There may be pain in the region of the clot with some tenderness but at first there may be little or no swelling or fever The pulse rate may be increased, swelling is present later in about 60 per cent of the cases, and thrombophlebitis with febrile reaction and leukocytosis may appear as a complication. It is in phlebothrombosis, with the clot lying loosely in the vessel and not adherent to the intima of the vein, that pulmonary emboli are most apt to occur

The treatment of thrombophlebitis is elevation of the leg, and, with disappearance of edema the encouragement of active exercise of the extremity Blocking of the sympathetic ganglia by paravertebral injections of procaine hydrochloride is helpful in relieving the vasospasm. Dicumarol and Heparin are useful in preventing extension of the thrombus.

Phlebothrombosis should be treated by phlebotomy removal of the thrombus, and interruption of the femoral vein. Anticoagulants should be used if emboli should appear after the operation, and may be given if desired even though no such phenomena occur When there is difficulty in deciding whether the patient has an early thrombophlebitis or phlebothrombosis, one may open the vein, remove the clot if possible, and interrupt the vein as described above. The sympathetic ganglia may be injected later if there are inflammatory changes.

TECHNIQUE

Suture of Blood Vessels

Very fine silk, which has been soaked in liquid petrolatum, and correspondingly fine round needles, either straight or curved, should be used. If the vessel has been cut in two a rubber shod serrefine clamp is applied a short distance from each stump to control the bleeding The open ends of the vessel should be thoroughly washed with 2 per cent *sodium citrate* solution to remove blood clots, and the vessel should be kept moist with this solution during the course of the operation. Often the adventitia of an artery projects as a ragged cuff beyond the end of the vessel. This should be grasped with forceps stretched out, and cut off to leave a smooth surface for suturing Three equidistant interrupted sutures should be inserted in such a way that the vessel ends are held together and can be pulled out in a triangular fashion. These sutures are tied and held by hemostats. *The three limbs of the triangle are now sutured, using* a running stitch (Figure 241) and being careful to assure approximation of the intima. After each limb has been completed, the suture is tied to the interrupted suture before it continues onward. The clamps are now re-

moved, the distal one being taken off first, and the anastomosis is in spected for leakage If necessary one or two more interrupted sutures may be put in. Mattress sutures may be used throughout if desired

If a longitudinal wound is present in a vessel the procedure is essentially the same Hemastasis is secured above and below the wound by the

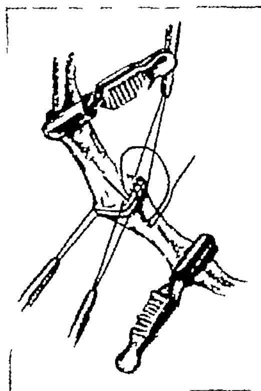


FIG. 241 *Blood Vessel Suture* Three guy sutures have been introduced to pull the vessel ends out in the form of a triangle. The first side of the triangle is being sutured with fine silk. After the other two sides have been sutured, the guy sutures will be removed. In the case of an artery the distal clamp on the vessel is removed first to avoid excessive pressure on the suture line. For large vessels the guy sutures may be omitted, the vessel ends being brought together by mattress sutures.

application of clamps, the vessel is washed out, and the wound is sutured in a linear fashion by a single layer of fine silk. Many small wounds of the veins do not require suturing, since if the gloved finger is applied for a short time to the vessel wall the bleeding will stop.

Embolectomy

Since the femoral and external iliac arteries are the peripheral vessels most frequently affected by embolism, the technique for the removal of an embolus from these arteries will be described. The location of the embolus is determined by the absence of pulsation in the artery below the embolus and, in the case of the femoral artery the vessel is exposed above this point. If the embolus is lodged in the external iliac or at the origin of the common iliacs, no pulsation will be felt in the femoral artery and an attempt should be made to remove the embolus by opening the femoral artery and pulling the embolus down The femoral artery is ex posed in the upper part of the thigh by a longitudinal incision in Scarpa s triangle. If no pulsation is felt in the vessel a piece of rubber tissue such

as a Penrose drain, is passed around the artery so that if bleeding begins it can be controlled. A longitudinal incision about 1 cm. long is made through the wall of the artery and a fine silk suture is passed through each lip of the wound to hold it open. If a thrombus is visible it is grasped with forceps and carefully to avoid injury to the intima, pulled out (Figure 242A) If no thrombus is visible a curved hemostat may be gently

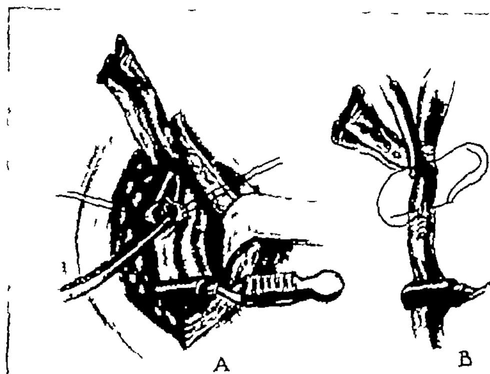


FIG 242. *Embolectomy* A A clamp has been applied to the artery below the embolus and an incision has been made in the artery The embolus is being removed A piece of rubber tissue has been passed around the artery to control bleeding after removal of the embolus. B The rubber tissue has been tightened and the opening in the artery is being closed.

inserted upward into the artery a short distance, in an attempt to grasp the clot. If this maneuver is not successful, a catheter with the end cut off and attached to a suction machine is passed upward and pulled out repeatedly As soon as the clot has been extracted, free hemorrhage begins from the wound in the artery and the rubber tissue should be tightened or a rubber-covered clamp applied. The artery below the clamp is washed out with 2 per cent sodium citrate solution and the wound in the vessel closed with a continuous suture of fine silk (Figure 242B) The clamps or ligatures on the vessel are now released and the wound is closed.

If pulsation is encountered in the upper part of the femoral artery but no pulsation is felt lower down, a clamp or ligature of rubber should be applied to the artery in the pulsating region and after incising the artery, the lumen of the vessel is probed or aspirated in a distal direction It is important not to apply a clamp or a ligature to the vessel in the region

where the thrombus is located, since with the constriction of the lumen thus produced the thrombus cannot be extracted without tearing it in two

Ligation of the Common Carotid Artery

The common carotid artery which has its origin from the arch of the aorta on the left and the innominate trunk on the right passes upward behind the sternoclavicular joint and takes its course in the direction of the angle of the jaw Pressure made just in front of the sternocleidomastoid muscle at the level of the cricoid cartilage compresses the artery against the carotid tubercle, a tuberosity on the transverse process of the sixth cervical vertebra, and this is an important landmark in its ligation. Pressure may also be made here for several minutes at a time before the operation, in order to test the effect of loss of unilateral carotid blood supply This test is not entirely reliable as hemiplegia may not develop until several hours after ligation of the vessel. Because of the profuse anastomoses between branches of the external carotid arteries of the two sides, cerebral complications are not so likely from ligation of the common carotid artery as they are from ligation of the internal carotid only but a two-stage ligation is safer

An incision is made from the lower level of the larynx to the sternoclavicular joint, the superficial fascia and platysma are incised, the superficial veins are cut and tied when necessary and the deep fascia is cut along the anterior margin of the sternocleidomastoid. This muscle is retracted backward and the sternohyoid muscle is retracted forward. The artery is enclosed with the jugular vein and vagus nerve in the carotid sheath, the vein being lateral to the artery and the nerve between the artery and vein and posterior The omohyoid muscle crosses the carotid sheath in the lower third of the neck and, since the artery terminates opposite the superior margin of the thyroid cartilage, it may also be ligated above this muscle by making an incision about 8 cm. long parallel to the anterior margin of the sternocleidomastoid muscle and centered at the level of the cricoid cartilage. The subcutaneous fascia and platysma are incised, and the sternocleidomastoid muscle is retracted backward. At this level the descending branch of the hypoglossal nerve should be watched for and avoided where it lies on the carotid sheath. The sheath is opened, the artery is identified by its whitish appearance and pulsation, and a ligature is passed around it, avoiding the vagus nerve which lies between the artery and the vein and behind them both. To ligate an artery of this size, it is best to use a wide piece of tissue, such as a strip of fascia lata, since this has less tendency to injure the intima than the ordinary silk ligature. Injury to the intima might result in the formation of a thrombus which could extend upward from the point of ligation. Before the ligature is tightened, the artery should be compressed with the fingers or a rubber-covered clamp for several minutes, in order to determine if

any immediate cerebral symptoms are produced, but in any case it is better to occlude the lumen only partially by the ligature and complete the ligation by reopening the incision a week later

Ligation of the External Carotid Artery

Ligation of the external carotid artery is sometimes of value to control hemorrhage from inoperable malignant lesions in the region of the face, mouth, and tongue. At the level of the superior margin of the thyroid cartilage, the common carotid artery forms a dilatation known as the carotid bulb and divides into its two branches, the internal and external carotid arteries, the former continuing in the general direction of the common carotid. The external carotid arises in front of and somewhat medial to the internal carotid, and passes upward and backward to the angle of the mandible. The best point for ligation of the artery is very close to the greater horn of the hyoid bone. An incision is made parallel to the anterior margin of the sternocleidomastoid muscle centered opposite the greater horn of the hyoid. The sternocleidomastoid is retracted backward and the posterior belly of the digastricus which crosses the artery in the upper part of the wound, is located. The hypoglossal nerve should be avoided by retracting it upward. The external carotid can be distinguished from the internal carotid by its location and by the presence of branches, since the internal carotid gives off no branches in the neck. The artery is ligated with heavy silk or fascia and, because of the profuse anastomosis between the arteries of the two sides it is advisable to ligate also the superior thyroid, lingual, and external maxillary branches.

Ligation of the Internal Carotid Artery

After temporary arrest of the internal carotid as described under ligation of the common carotid, the vessel is exposed by the same incision used for the external carotid artery The artery may be ligated a short distance above its origin, using a strip of fascia lata about 1 cm. wide or heavy silk. It is safer to reduce the lumen of the artery only partially at the first operation and, if the patient shows no symptoms, to reopen the incision about a week later and completely tie off the vessel.

Arteriovenous Fistula

Quadruple and Sextuple Ligation and Excision An incision is made over the region of the fistula in the course of the artery and the aneurysm is carefully dissected out. It is necessary to ligate and cut all vessels communicating with the sac. Blood flow should be controlled by passing a strip of rubber tissue such as a Penrose drain, around each of the vessels and holding it tight with a hemostat. The artery and vein should be ligated with silk above and below the fistulous communication, and the involved vessels with the aneurysm severed and removed. In sextuple

ligation, the procedure is the same except that two veins are ligated above and below in addition to the artery and communicating vessels.

Transvenous Arteriorrhaphy with Obliteration of the Vein After exposure of the fistula and ligation of all communicating vessels, the artery and vein are compressed above and below the fistula. The vein is opened by a longitudinal incision in the region of the fistula and the communication between the artery and vein is closed by very fine interrupted silk sutures. The vein is ligated above and below the communication and excised, except for the portion involved by the suture line. If desired instead of excising the vein it may be ligated above and below and the vein plicated by silk sutures further to reinforce the opening in the artery

Aneurysm

When the collateral blood supply is sufficient, an aneurysm should be treated by proximal and distal ligation of the involved artery The ligature should be placed close to the aneurysm, and whenever possible the aneurysmal sac should be removed.

Aneurysmorrhaphy The aneurysm is exposed by a longitudinal incision and the blood supply is controlled either by tourniquet or by encircling rubber tubes. All vessels that communicate with the sac, except the main artery are ligated and cut. The sac of the aneurysm is opened and the cavity is obliterated by multiple interrupted silk sutures. If the communication between the aneurysmal sac and the artery is small this opening should first be closed. If the artery itself enlarges as a fusiform aneurysmal sac, an attempt may be made to leave a channel for blood along the most convenient side of the sac suturing the inner walls of the sac together over a catheter which is removed before the last sutures are put in. The sac is then obliterated as described above.

Varicose Veins

Varicose veins of the lower extremity are treated by the injection of 2 cc. of 5 per cent sodium morrhuate into a segment of dilated vein once or twice a week. Each injection causes thrombosis in the vessel over a distance of about 5 cm. from the point of injection. Care should be used to avoid leakage of the solution into the tissues, since it is apt to cause sloughing. When varicose veins are present above the knee and the deep veins have been proved to be patent by appropriate tests the injection treatment may be combined with ligation of the great saphenous vein. The operation can easily be done under local anesthesia. A transverse incision about 5 cm. long and 4 cm. below the inguinal ligament is centered just medial to the point of maximum pulsation of the femoral artery When this incision is deepened through the skin and superficial fascia, the saphenous vein will be approached about 1 cm. below its termination in the femoral vein at the fossa ovalis. A hemostat should be passed under

neath the vein, and it should be lifted up so that its branches can be identified and ligated in that region. The superficial epigastric, superficial circumflex iliac, and superficial external pudendal veins should be interrupted,



FIG 243. *Ligation of Saphenous Vein* The vein has been exposed at the fossa ovalis and its branches have been tied and divided A ligature has been tied around the vein and another ligature is in place ready for tying as soon as the solution has been injected The second tie will be made below the needle puncture wound and the vein will be cut in two between the ligatures.

and occasionally a large accessory saphenous vein from the posterior and medial parts of the thigh may join the main vein at this level. The hemostat under the vein is used to draw underneath it two pieces of #1 chromic catgut. With one of these, the vein is tied at as high a level as possible and a single knot is made in the other so that it can be tightened as soon as the injection has been given. With a hypodermic syringe and

needle 2 cc. of 5 per cent sodium morrhuate are injected distally into the vein (Figure 243) As the needle is withdrawn, the prepared suture is tied just below the puncture wound and the vein is cut in two between the ligatures. If there has been any leakage of the solution the wound is thoroughly washed out with normal saline solution. The wound is closed with a continuous suture of plain catgut for the fascia and dermal for the skin.

When it is desirable to ligate the small saphenous vein, a short transverse incision is made at the level of the lower margin of the popliteal fossa. The vein is exposed in the midline of the leg and is dissected out at the point where it pierces the deep fascia to join the popliteal vein. The vein is cut, ligated, and injected by the method described for the great saphenous vein

If ligation of the communicating veins is necessary one or two more incisions the entire length of the leg are necessary To expose the anterior group the incision is made just lateral to the anterior margin of the tibia, from the tubercle to the dorsum of the foot. The medial group are approached by an incision along the posteromedial margin of the tibia down to the medial aspect of the calcaneus. For the lateral group the incision is made on the posterolateral surface of the leg ending just behind the lateral malleolus. In each case the incision is deepened through skin subcutaneous tissue, and deep fascia. The fascia is elevated and retracted, and the veins are cut and ligated between the deep fascia and the underlying muscles. The fascia is closed and the skin is sutured as usual.

When the patient is ambulatory he is instructed to wear an elastic bandage for several months until any edema that may be present subsides.

Paravertebral Injection of Sympathetic Ganglia

For the lower extremity injections are made at the levels of the first four lumbar vertebrae. For the upper extremity the inferior cervical ganglion is injected at the level of the first thoracic vertebra.

With the patient lying on the sound side the skin is prepared and a wheal is raised with procaine hydrochloride at the point where the needle is to be inserted. This should be about 4 cm. from the midline and in the lumbar region at the level of the vertebral spine. In the thoracic region, the needle is inserted at the level of the seventh cervical spine which corresponds to the level of the first thoracic vertebra. A long 20-gauge needle is inserted inward perpendicular to the skin surface until it strikes the transverse process or rib The needle is then withdrawn slightly and redirected higher or lower to miss the transverse process or rib. On reinsertion it should strike the vertebral body and should then be turned slightly more lateral, to pass by the body but stay not more than 2 mm. away from it. This is especially important in the thoracic region, in order to avoid the pleura. The ganglion lies on the anterolateral surface of the

body of the vertebra. After aspirating to be sure the needle is not in a blood vessel, 10 cc. of 1 per cent procaine hydrochloride is injected and the needle is withdrawn. In the lumbar region, similar injections are made at the levels of the other three vertebrae. (Injection is not made at the fifth lumbar vertebra.)

After completion of the injection, the skin of the extremity should become warm and dry and the superficial veins may be more conspicuous. After injection in the region of the inferior cervical ganglion, Horner's syndrome should appear

The injection usually must be repeated two or three times before the pain is relieved permanently

Ligation of Femoral Vein and Removal of Thrombus

An incision about 8 cm. long is made along the course of the femoral artery its upper end beginning at the crease in the groin. The incision is deepened with careful retraction of the lymph vessels, so that no more of them are divided than necessary Near the center of the incision, the upper portion of the femoral vein will be encountered, and its junction with the profunda femoris is marked by a bulge in the femoral vein. The artery is pulled aside, but great care is used in handling it to prevent injury to the intima. The vein is isolated for a distance of 2 or 3 cm. and two silk ligatures are passed around it, but not tied. An incision is made in the wall of the vein between the ligatures and thrombi are removed by suction until free bleeding from both sides of the vein is obtained. To remove the clot, a glass tube or open-ended rubber catheter connected to a pump by a rubber tube is most satisfactory Care must be used not to continue withdrawal of blood after the clot has been extracted, since the patient may be exsanguinated very quickly in this way The ligatures are now tied and the intervening segment of vein, usually about 2 cm. long, is excised. If there are any communicating branches at this level they are cut and tied before the clot is extracted. Care should be used not to leave a long proximal stump of femoral vein below the level of the profunda, since thrombosis is apt to occur in such a segment. If the deep femoral vein is found to be thrombosed, it also is ligated to keep emboli from originating from this source. If there is evidence of thrombophlebitis in the iliac vein and the clot has been present for a week or more, it will probably be found to be so adherent that it cannot be removed by suction through the femoral vein and, particularly if septic infarcts are arising from it, it is justifiable to ligate the vena cava just above the bifurcation.

Ligation of Inferior Vena Cava

The abdomen is opened through a right paramedian or midline incision. The patient is placed in a Trendelenburg position and the bowel is packed away from the pelvis. The vein lies behind and somewhat to the right of

the aorta, and the peritoneum is incised just above the bifurcation of the
aorta. The peritoneum is stripped aside to expose the vein, and two silk
...ed around it but not tied. If a clot is present in the vein
...d by suction with a catheter
lace are used to control
until free bleeding is ob... the thrombus the vein is doubly ligated.
bleeding and after removal of the thrombus the vein is doubly ligated.
The peritoneum is closed by a few catgut sutures and the abdominal wall
is closed as usual.

An extraperitoneal approach for this operation may readily be made
by an incision preferably transverse, on the right side just below the level
of the umbilicus. The incision should extend well into the flank and, after
dividing the muscles, the peritoneum is retracted medially until the ureter
and vena cava are exposed.

POSTOPERATIVE CARE

To prevent intravascular clotting, anticoagulants may be given When
a immediate effect is desired Heparin must be used, since Dicumarol
must be administered for two or three days before its full action is ap-
parent. Before an anticoagulant is given, one should first be sure that the
patient's blood clots normally Bleeding and clotting time and prothrom-
bin time determinations are made, and only if these periods are not pro-
longed should Heparin or Dicumarol be used.

Heparin is given intravenously every four hours in a dose of 50 mg
The administration of the drug is controlled by the coagulation time
which should be taken every hour until the reaction of the patient is de-
termined. The coagulation time should be kept at three times the normal
level, and if it becomes too prolonged the dosage should be decreased.

When Dicumarol is used, the initial dose is 200 to 300 mg depending
on the weight and general condition of the patient. The prothrombin time
is determined on the second day and only if the prothrombin activity is
above 25 per cent is more of the drug given. The prothrombin time is
preferably obtained in the morning, and the daily dose of the drug is not
given until the report is available. Maintenance doses are usually from
100 to 200 mg.

Dicumarol may be started at the same time as Heparin if desired, and
the latter discontinued at the time the Dicumarol becomes effective
Heparin is al... ...ailable in a medium that permits its subcutaneous or
intramuscular ... ...hat only one daily injection
is necessary ... perimental stage.

Anticoagulants should not be given ... re is a granulomatous or
ulcerative lesion, or when there is impaired hepatic or renal function and
this includes the presence of jaundice. It should be used carefully in pa
tients with fever or in poor nutritional state, and in patients who have
had intrathoracic operations or operations on the brain or spinal cord,

the drug should be used with caution, if at all, because of the danger of hemorrhage. With prothrombin activity reduced to less than 10 per cent of normal, there is definite danger of hemorrhage. Dicumarol should not be administered preoperatively and if the prothrombin time is prolonged in patients who are to have a surgical procedure repeated transfusions of fresh blood should be given until the prothrombin time has returned to normal or nearly so These transfusions should be repeated postoperatively as required, to keep the prothrombin time near normal level. Vitamin K is also of value in returning the blood to normal.

CHAPTER XXIX

The Extremities

PREOPERATIVE PREPARATION

LESIONS OF THE EXTREMITIES

- Congenital Anomalies
- Contractures
- Injuries
- Inflammation
- Gangrene
- Infections of the Hand

TREATMENT AND TECHNIQUE

- Congenital Anomalies
- Contractures
- Injuries
- Inflammation
- Gangrene
- Amputations
- Infections of the Hand

POSTOPERATIVE CARE

The Extremities

PREOPERATIVE PREPARATION

The usual preoperative procedures outlined in Chapter I are applicable here. When amputation is performed because of an acute injury of an extremity preoperative treatment for shock is required in most cases.

LESIONS OF THE EXTREMITIES

Congenital Anomalies

Many congenital defects of the extremities are possible some of them the result of constriction of the extremity by an amniotic band and some of a defect in the germ plasm.

Polydactylism Supernumerary fingers or toes are frequently seen and are usually hereditary

Macrodactylism Abnormal enlargement of one or more digits may be encountered. The middle finger is most commonly affected.

Syndactylism Fusion of the fingers or toes is a fairly common abnormality The bones are usually normal and the digits are bound together by skin A similar condition may follow an improperly treated burn of the fingers

Manus Valga In this condition which is due to an abnormality of the lower radial epiphysis, there is an outward bowing of the lower end of the radius so that the hand is displaced toward the radial side. There is an associated ulnocuneiform dislocation.

Contractures

Ischemic Contracture This type of contracture usually follows constriction produced by a cast or bandage. Fibrous degeneration and atrophy of the muscles occur and when the forearm is affected flexion of the wrist and fingers takes place.

Dupuytren's Contracture Thickening and shortening of the palmar fascia may produce a flexion deformity of the fingers. The tendons are not directly involved.

Injuries

Severed Tendons and Nerves The general treatment of wounds of the extremities is discussed in the chapter on The Bones and Joints. The presence of a divided tendon is determined by finding the cut ends in the wound or by demonstrating the patient's inability to use the muscle involved. Severed nerves may be evident in the wound, or motor paralysis or loss of sensation may be present

Ganglion A cystic tumor containing gelatinous or mucoid material occurs very commonly in the region of a tendon sheath or in the neighborhood of a joint capsule or even within a tendon The dorsum of the wrist is the most frequent location but the condition is also seen on the volar surface of the fingers, the volar surface of the wrist the dorsal surface of the foot, and elsewhere It forms a slightly fluctuating but rather firm rounded swelling somewhat movable but closely associated with a tendon.

Baseball Finger This is a common injury produced by a blow on the end of the extended finger There may be a transverse fracture of the proximal end of the distal phalanx or tearing of the ligaments of the joint and a rupture of the insertion of the extensor tendon. The patient is unable to extend the terminal phalanx (mallet finger)

Glomus Tumor The glomus tumor usually occurring on the fingers or toes, frequently underneath a nail is a neoplasm of the special arteriovenous anastomoses in the skin. The growth consists of a minute mass of dilated blood vessels, nerve fibers, and smooth muscle cells, which grossly appears as a bluish, rounded, sometimes raised area about 1 mm. in diameter Pressure on it causes excruciating pain, which tends to shoot up the extremity If the lesion is incised it bleeds profusely

Inflammation

Bursitis Inflammation or trauma may cause distention of a bursa by fluid. If the condition is acute, redness and pain will be present. Suppuration not infrequently occurs. Tuberculosis may be the etiologic factor in some cases.

Bursae most commonly involved are the prepatellar the olecranon, and the subdeltoid.

Ingrown Toenail This is most commonly seen on the great toe the soft tissues being pushed against the edge of the nail by the shoe. Irritation of the soft tissues with infection and ulceration takes place.

Gangrene

Death *en masse* of part or all of an extremity may be due to circulatory disturbance, excessive heat or cold, infection, chemical action, or X ray or radium therapy Arterial obstruction, if not the primary cause of the condition, is usually a contributing factor regardless of the etiology

grene primarily due to circulatory disturbance may be caused by arteriosclerosis with or without diabetes thromboangiitis obliterans, Raynaud's disease, poisoning by ergot arterial thrombosis or embolism, or the interruption of a main artery by injury or ligation. Venous obstruction due to thrombosis or to interruption of a large vein may also cause gangrene. Deep burns or frostbites or burns by radiation therapy are common etiologic factors, and the application of a drug such as carbolic acid to a finger or toe may cause death and loss of the digit. Infection with gas-producing organisms causes diffuse necrosis of tissue, and associated with this there is vascular thrombosis.

Gangrene may be moist or dry the first type occurring when the part is congested or infected or both. In the moist type, the skin becomes brownish to green or black in color bullae form and the part becomes swollen and has a foul odor In dry gangrene, the part becomes mummified it is dry black, leathery shrunken and has little or no odor

A line of demarcation gradually forms between the gangrenous and the normal regions, but the line is much less sharp in moist gangrene because the infection tends to spread beyond the dead area.

Infections of the Hand

Lymphangitis Any deep or superficial infection of the hand, and this is true of what appears to be a trivial lesion of the skin may be followed within a few hours by evidence of lymphangitis. There is swelling of the involved portion of the hand with redness, and red streaks are seen extending upward to the region of the axillary lymph glands. When the patient's resistance is poor or treatment is delayed, septicemia may take place and metastatic abscesses may occur or the patient may die within a short time.

Paronychia Infection of the tissues along the side of the nail may be caused by 'hangnail puncture wound, or abrasion. The infection has a tendency to travel across the base of the nail (eponychia) to the tissues on the other side of the nail.

Eponychia Infection of the tissues at the base of the nail may be secondary to paronychia or may be primary there. Swelling is apparent and a drop or two of pus can be expressed between the eponychium and the nail A common complication of eponychia and paronychia is subungual abscess.

Subungual Abscess This condition may be due to extension of an infection described above or may be caused by an injury such as the penetration of a splinter under the nail. In the first instance the infection and pus are located at the base of nail and in the latter the pus is apt to be located at the deepest point of the foreign body

Felon A penetrating wound of the ball of a finger or infection of the skin in that region tends to produce an infection in the distal closed

space. The ball of the finger becomes swollen and distended with pus and if not treated the infection extends to and destroys the bone With bone necrosis pus will be discharged until the dead bone is removed.

Furuncle and Carbuncle These are usually located on the dorsum of the hand or finger and resemble similar infections elsewhere The bacteria gain entrance into the skin through the sweat glands or hair follicles.

Infection of the Dorsum of the Hand On the dorsum of the hand pus may accumulate just underneath the skin (dorsal subcutaneous space) or between the extensor tendons and the metacarpal bones (dorsal subaponeurotic space) The subaponeurotic space may be infected by extension from a diseased metacarpal bone or by the burrowing of an abscess that arises in the palm usually near the distal end. The extensive edema of the dorsum of the hand, which nearly always accompanies infection of the palmar surface of the hand should not be mistaken for an abscess on the dorsum. The tendon sheaths of the dorsal tendons are short and of little importance in the spread of infection but an inflammatory process may extend upward on the dorsal surface of the wrist to the forearm.

Collar Button Abscess Originating usually from a callus at the base of a finger near the distal end of the palm an epidermal infection may extend under the dermis (collar button abscess) and may further extend to the dorsal subaponeurotic space.

Web-Space Infection Infections of the space in the web between two fingers may likewise extend to the tissues on the dorsum of the hand, or may extend along the lumbrical muscle to a neighboring space in the hand.

Infection of the Thenar Space This space lies deep in the palm but superficial to the adductor pollicis. It is located lateral to the middle metacarpal bone and medial to the thenar eminence, the median boundary being in line with the adduction crease of the thumb. This space may be involved by extension of an infection from the index finger or as a result of osteomyelitis of the first or second metacarpal, or by extension from an infection of the middle palmar space. In infection of the thenar space, the thenar region becomes ballooned up flexion of the thumb takes place and the first metacarpal is pushed laterally There is great swelling of the dorsum of the hand, but pus is not present there unless extension should occur to the dorsum between the first and second metacarpals.

Infection of the Middle Palmar Space This space, which is separated from the thenar space by a fibrous septum that is most permeable at its proximal end, is overlapped on the medial side by the ulnar bursa. On the distal end of the space are three projections that extend along the lumbrical muscles

Infection of the middle palmar space is marked by bulging of the palm

of the hand and, with extension along the lumbrical canals to the base of the fingers, there is swelling of the tissue of the webs. Owing to the close proximity of the flexor tendons which overlie the anterior wall, the fingers are held in a flexed position, the index finger however being less involved than the others. In association with infection of the middle palmar space there is commonly swelling of the thenar space, but this is due to edema and does not have the tense induration of infection.

Suppuration in the middle palmar space may be caused by the extension of an infection from the middle and ring fingers, or less commonly the little finger from the lumbrical canals between the heads of the metacarpals, or from the ulnar bursa. Osteomyelitis of the fourth and fifth metacarpals or a penetrating wound may also infect this space. Extension of a middle palmar space infection may take place to the thenar space and along the lumbrical muscles of the third, fourth, and fifth fingers to the webs of the fingers, and thence to the dorsum of the hand, or occasionally infection may pass under the annular ligament beneath the tendons into the forearm.

Infection of the Hypothenar Space This is a less sharply defined space in the hypothenar region, which is anatomically fairly well isolated from the rest of the hand. An infection arising here usually remains localized and produces swelling and pain without involvement of the tendons

Infection of the Major Forearm Space This space lies deep to the flexor digitorum profundus tendon and on top of the pronator quadratus muscle and the interosseous membrane. It extends from the region of the annular ligament upward, where it joins the intermuscular planes. The space is nearly always infected by rupture of the ulnar or radial bursa into it. The forearm becomes tensely swollen, there is deep tenderness on palpation, and the patient holds the wrist in a fixed position.

Tenosynovitis Infection of the tendon sheath of a finger is marked by diffuse enlargement of the entire finger, tenderness over the course of the sheath, flexion of the finger and severe pain when an attempt is made to extend it. All of the fingers may be somewhat flexed and may be swollen, but the swelling is not so great and the pain caused by extension of the other fingers is not so pronounced.

Extension from a tenosynovitis of the little finger involves the ulnar bursa, with a particular area of tenderness at the junction of the hypothenar eminence with the distal flexion crease. With extension of the infection to the radial bursa, the thumb becomes flexed and shows pain on extension and there may also be swelling of the thenar area. Further extension of the infection in the ulnar bursa results in infection of the major forearm space. The lumbrical space which lies close to the tendon sheath, frequently becomes infected and in this way the tendon of an adjacent finger may be involved. The tissues in the web of the finger become swollen and red. The middle palmar space may be involved by extension

from the lumbrical space or by rupture of the ulnar bursa, but the thenar space is never affected.

Infection of the tendon sheaths of the index, middle and ring fingers extends to the lumbrical space thence either to the palmar spaces or to the dorsum of the web. Tenosynovitis of the middle and ring fingers usu ally infects the middle palmar space, and tenosynovitis of the index finger infects the thenar space.

Infection of the tendon sheath of the thumb extends first to the radial bursa, and may pass into the ulnar bursa or above into the major forearm space.

TREATMENT AND TECHNIQUE

Congenital Anomalies

Polydactylism Extra fingers and toes should be amputated in infancy

Macrodactylism Congenital hypertrophy most frequently affects the middle finger but the index finger or thumb may be involved. Partial amputation of the enlarged finger or complete removal of the digit may be indicated for cosmetic reasons or to improve the function of the hand

Syndactylism Fusion of the fingers should be corrected by cutting the skin and soft tissues between the digits. The skin of the dorsum of the hand is loosened at the base of the fingers and a V shaped strip is pulled through between the fingers and sutured in place to keep them sepa rated. The remaining raw surfaces on the adjacent sides of the fingers may be covered with skin grafts if desired.

Manus Valga Osteotomy should be performed on the lower end of the radius to correct the position of the hand. The ulnocuneiform dislocation is reduced and the forearm is placed in a plaster cast.

Contractures

Ischemic Contracture Surgical treatment for this condition is very unsatisfactory If physiotherapy and the usual measures for active and passive extension of the contracted part are not effective, partial relief may sometimes be obtained by judicious tendon transplantation.

Dupuytren's Contracture Two or more incisions are necessary One should follow the distal flexion crease across the palm, from the medial edge to the medial margin of the second metacarpal. The second incision follows the crease around the thenar eminence and extends from the medial surface of the first metacarpal bone up to the wrist. Short longi tudinal incisions through the web between the index and middle finger and between the middle and ring finger and a lateral incision at the base of the middle finger may be necessary also The skin of the palm of the hand is elevated from the underlying fascia by sharp dissection the fascia is divided transversely just beyond the insertion of the palmaris longus

and removed as completely as possible along with its deep attachments. The nerves and vessels to the fingers should be identified and guarded. The digital extensions of the fascia must be removed. Unless there is severe contracture with shortening of the flexor tendons, it should be

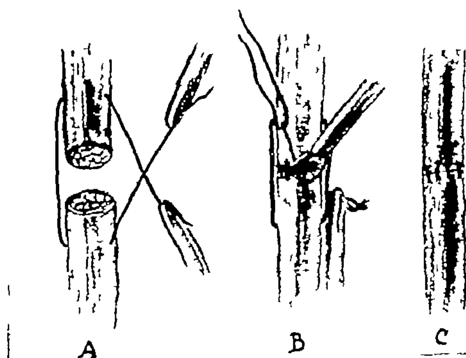


FIG. 244. *Nerve Suture* A. A tension suture has been inserted to hold the nerve ends together B Interrupted sutures of fine silk are used to bring the epineurium of the two ends together C. The suturing is completed and the tension suture has been removed.

possible to extend the fingers easily after completion of the operation. Occasionally it may be necessary to remove the palmar skin and replace it with a full thickness or tubed pedicle graft. A splint is applied to the hand after closure of the incision, and it is usually advisable to have the wrist flexed so that the fingers can be completely extended without tension. Hot wet dressings may be applied for the first twenty four hours. The splint should be worn at night for several weeks, but during the day it may be removed when the skin is healed, and active and passive motion of the fingers may be instituted.

Injuries

Severed Nerves Primary suture that is suture of the nerve immediately after the injury should be performed whenever possible If suppuration later develops in the wound it will probably interfere with healing, but at least retraction of the nerve ends will not occur and secondary suture will be easier In primary suture, any torn or crushed part of the nerve trunk should be cut off with a sharp knife or razor blade and the

two ends should be approximated by a tension suture introduced some distance back from the ends and held temporarily by a hemostat (Figure 244A) With the tension on the nerve thus relieved, interrupted sutures of the finest silk should be used to approximate the epineurium (Figure 244B) When the sutures have been inserted, the tension suture is removed (Figure 244C)

When secondary suture of a nerve is being done if the nerve ends have been separated for a period of time bulbous enlargement will be found on the end of each segment. This should be cut off and the nerve sectioned back until normal tissue is seen. It may be necessary to make a long incision parallel to the course of the nerve to dissect it free from the enveloping scar tissue and after the suturing is completed the nerve should be placed whenever possible on a bed of healthy muscle. If it is found that the nerve ends will not come together because of retraction or loss of tissue, sometimes flexion of the extremity will bring the ends together in other cases the nerve may be rerouted by a shorter path. The ulnar nerve for instance may be moved from its position behind the condyle of the humerus to the front of the elbow If none of these measures is sufficient to approximate the nerve ends the extremity may be flexed and the nerve ends tied together by heavy sutures and with gradual extension of the extremity the nerve may be stretched enough to suture it later

Severed Tendons Cut or ruptured tendons should be sutured at once n a fresh wound this should be done as soon as the hemorrhage is brought nder control and at the time the cut nerves are sutured. If a suppurating ound is present, suturing is useless, since the sutures will not hold and e manipulation necessary may spread the infection. When many tendons cut, such as in a wound of the wrist, great care should be used to get corresponding ends together The position and size of the tendons s in this, and the distal stump can be pulled on to show its insertion When there is retraction of the ends liberal longitudinal incisions should be made as required to catch the ends and pull them together Many complicated and sometimes impractical methods of tendon suturing have been described, but in my experience only three things are necessary first, the ends of the tendon must be approximated second, the sutures used must be strong enough to hold the ends together and third, no more suture material should be used than necessary Simple through-and through sutures of silk are used and these are passed through the tendon far enough from the end so that they will not pull out by fraying it. The knot is placed on the outside of the tendon and not between the ends, since if an attempt is made to place the knot between the ends where it will presumably not cause roughness of the outside of the tendon, it is difficult to get the tendon ends in perfect apposition. A splint should be applied to the extremity and left on for about two weeks.

Ganglion If the swelling is associated with pain or is very conspicuous, it should be excised. An incision, usually transverse, is made over the ganglion, and the sac, which is filled with gelatinous material and may *surround the tendon and usually communicates with the tendon sheath,* is carefully dissected out. In many cases the sac must be opened, but it should be followed in all its ramifications and completely removed. When the ganglion communicates with a joint a portion of the synovial membrane in the region should also be removed. Although the procedure is time-consuming and requires careful dissection, and even if thoroughly done there is some tendency for the ganglion to recur I have found no other treatment that is at all satisfactory

Baseball Finger The finger should be splinted with hyperextension of the terminal phalanx. When this does not cure the condition, an incision may be made and the extensor tendon sutured to the periosteum at the base of the terminal phalanx.

Glomus Tumor The tumor should be excised completely the nail being removed when necessary

Inflammation

Bursitis· In acute cases, rest of the part, aspiration, and bandaging should be utilized. The aspiration may have to be repeated as the swelling recurs If suppuration develops, the bursa should be opened and drained. In chronic bursitis the sac should be excised.

Ingrown Toenail If packing the irritated skin away from the nail with cotton is not sufficient, the adjacent one-third or more of the nail should be removed. An incision is made parallel to the nail bed, the eponychium is grasped with an Allis forceps and dissected up the nail is cut off with scissors or a knife, and the matrix of that portion of the nail is destroyed with a curette (Figure 245) The eponychium is allowed to drop back in place, a vaseline dressing is applied, and the toe is bandaged. No sutures are necessary

Gangrene

Gangrene makes amputation necessary the amount of the extremity to be sacrificed being determined by the adequacy of the blood supply Injection of the sympathetic ganglia with procaine hydrochloride as described in the chapter on The Blood Vessels is helpful in increasing the blood supply to non gangrenous tissue. For permanent vasodilation, sympathetic ganglionectomy is performed. If one or two toes are involved, the toes may be amputated and measures instituted to improve the circulation. When the foot above the toes is affected by gangrene due to arteriosclerosis and the popliteal vessels are pulsating amputation may be tried below the knee If at operation the major arteries are found to be throm-

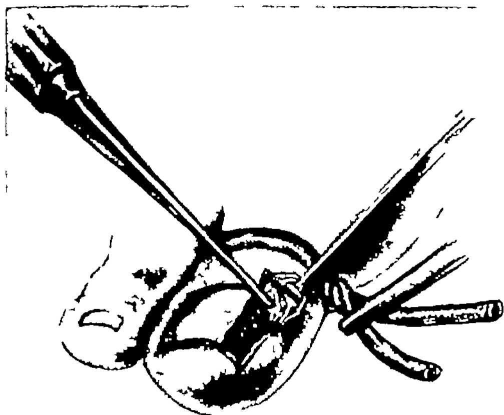


Fig. 245. *Operation for Ingrown Toenail* A flap of skin has been turned back at the base of the nail about one-third of the nail has been removed, and the matrix is being destroyed with a curette

bosed, the operation must be performed at the thigh. When the gangrene is of the moist type with infection it is better to amputate primarily above the knee.

Amputations

The Lower Extremity In amputations of the lower extremity the principal consideration, after healing of the stump has been assured, is to provide the patient with adequate means of locomotion No part of the extremity should be sacrificed unnecessarily but necessity sometimes demands loss of bone length in the interest of a satisfactory stump If four toes must be sacrificed, unless the remaining toe is the great toe it also should be taken off because a single toe will cause more trouble than it is worth. The distal part of the foot as far back as the tarsometatarsal articulation may be lost (Lisfranc amputation) and the patient will still have a useful weight bearing stump but if more of the foot must be removed it is usually better to amputate through the middle third of the leg Amputation through the lower third of the leg does not provide as comfortable a stump as does the middle-third amputation. Too short a stump

on the other hand, is not satisfactory and unless at least 7 or 8 cm. of tibia can be saved below the knee, amputation should be performed above the condyles of the femur The ideal site for thigh amputation is just above the condyles of the femur and from this point up all possible bone should be saved (Figure 246)

A long anterior and short posterior flap should be made in all amputations of the thigh or leg unless to do so would cause inordinate loss of stump length. In amputation through the leg the fibula should be cut off about 3 cm. higher than the tibia, and in high amputations of the tibia it may be advantageous to remove the fibula entirely The crest of the tibia is beveled off for about 2 cm. from the end so that there will not be a protruding sharp point.

In the presence of infection it may be advisable to cut all the tissues of the limb off at right angles (guillotine amputation) and use adhesive plaster postoperatively to pull the soft tissues down over the stump of bone. In many of these cases re-amputation or a plastic operation will be necessary on the stump In the guillotine amputation, the periosteum should not be removed from the terminal 1 cm. of bone, as is ordinarily done, because of the danger of bone necrosis.

Large nerves that are to be cut in the amputation are first isolated, pulled down, divided as high as possible, and the stump is injected with ethyl alcohol. The muscles should be brought together over the end of the bone, but if they are too bulky some of them are sutured together and only part of the muscle tissue is utilized. Large muscle pads on the end of the stump are not desirable, but the bone ends should be reasonably well covered and the opposing muscles should be connected together

A racket type of incision, with the curve on the plantar surface, is most satisfactory for amputation of a toe. Through an incision of this kind the end of the metatarsal can also be removed if necessary

A tourniquet should be used in amputations of the thigh or leg unless there is danger of its damaging vessels that are already diseased. All bleeding points should be carefully caught and tied, so that in the uninfected case, drainage will not be necessary The fascia should be closed over the muscles, and neither muscles nor fascia should be under tension nor should they be so loose as to form a flabby mass extending far below the end of the bone.

Refrigeration anesthesia is the method of choice in the elderly and debilitated patient.

Technique of Amputation of the Thigh in the Lower Third After the patient has been anesthetized, the leg is held up while a tourniquet is applied as high as possible. The entire circumference of the thigh is painted with two coats of an antiseptic solution, extending from the level of the tourniquet down well below the knee. A sterile sheet is placed on

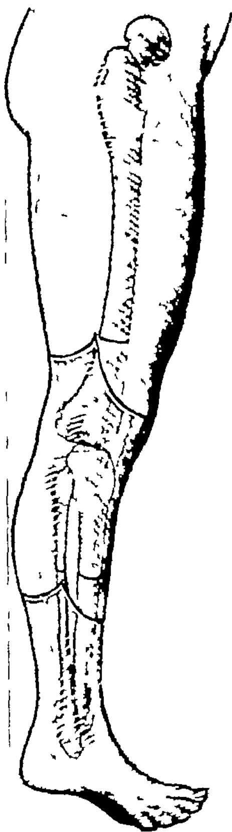


Fig. 248. *Incisions and Optimum Sites for Amputation in the Lower Extremity*

the table below the leg and thigh, and a stockinette or sterile sheet is used to cover the leg and foot up to the knee. The foot, leg, and thigh are now passed through the hole of a laparotomy sheet, the sheet is pulled up, and the opening is anchored to the thigh with towel clips just below the tourniquet. The surgeon outlines the flaps with the back of the knife mark

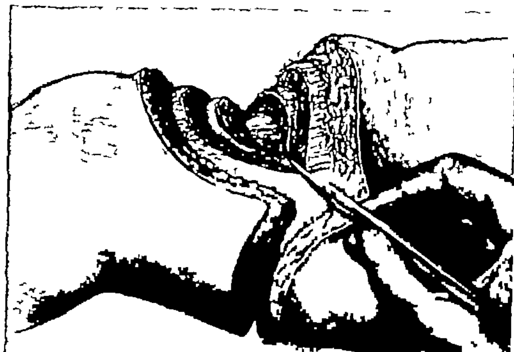


FIG. 247 *Amputation of the Thigh.* The skin has been incised and pulled upward and the muscles are being cut

ing out an anterior flap one and one-half times as long as the diameter of the thigh. The posterior flap is made about one-half as long as the diameter of the thigh. The lowest point of the anterior flap should be about 15 cm. below the point where the bone is to be sectioned. Beginning on the anterior flap the surgeon cuts through the skin and subcutaneous tissue and continues the incision around the posterior flap. The tissues are pulled upward a short distance, and the incision is continued into the muscles (Figure 247) The great saphenous vein should be doubly clamped and cut, and the section continued inward to the region of the femoral vein and artery These are identified, doubly clamped, and cut between clamps. In the posterolateral region, the sciatic nerve will be seen and should be pulled down for about 3 cm. injected with alcohol, cut, and the upper end allowed to retract (Figure 248) The profunda vessels on the posterior aspect of the femur should next be clamped and cut, as should other smaller branches that are seen during the operation. The muscles are now pulled upward on the exposed femur and a strip of periosteum about 1 cm. wide is removed from the bone just below the muscles. While the muscle is held out of the way

by towel slings held by an assistant the femur is sawed [illegible] taken away and the sharp edges of the bone are [illegible] rasp. The vessels are tied the hemostats are removed, and the [illegible] is released. Any bleeding vessels that now appear are [illegible] until bleeding has been perfectly controlled. If there is [illegible]

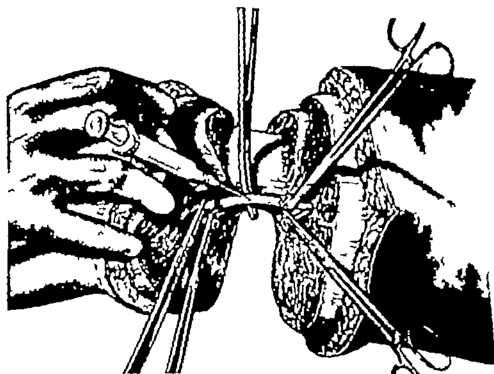


Fig. 248 *Amputation of the Thigh* The muscles have been cut, the vessels clamped, and alcohol is being injected into the sciatic nerve

end of the bone a small amount of bone wax should be pressed on it. The muscles are approximated over the bone by continuous or interrupted mattress sutures of catgut, the fascia is similarly brought together (Figure 249) and the skin is closed by interrupted sutures of silkworm gut (Figure 250) If hemostasis is not perfect or if infection is feared a soft rubber drain may be left in each angle of the wound. After the dressing is applied, a splint should be used to keep the thigh from flexing on the abdomen.

In the guillotine amputation, the vessels are tied and the sciatic nerve is injected with alcohol, but no closure of the wound is done. The raw surface is covered with a vaseline dressing.

The Upper Extremity Every possible part of a finger should be saved. If it is necessary to amputate part of the distal phalanx, the matrix of the nail should be destroyed so that a deformed nail will not grow from the stump In the case of the fingers, contrary to practice in other locations disarticulation at a joint is preferable to section of the bone. The tend[illegible]

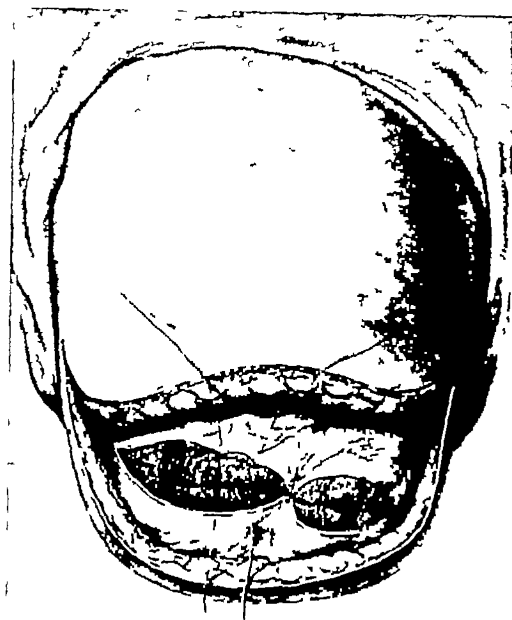


Fig. 249 *Amputation of the Thigh.* The muscles have been sutured over the end of the bone and the first suture has been placed in the fascia.

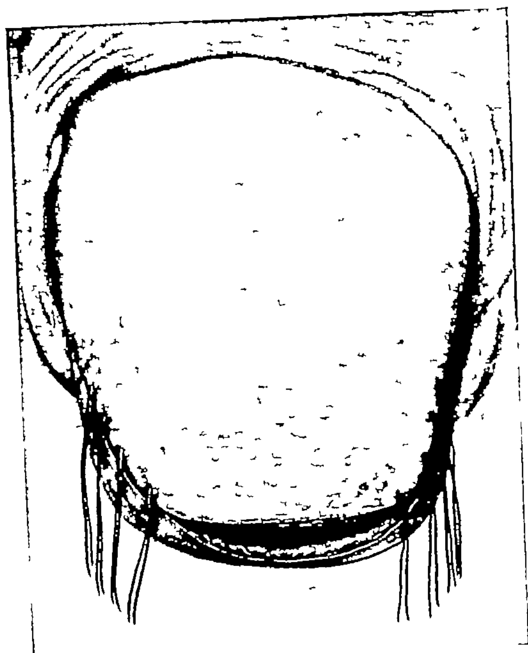


FIG 250. *Amputation of the Thigh.* The skin is being closed by interrupted sutures.

sheaths that have been opened should be closed by sutures to prevent ascending infection and the tendon should be included to fix it. A long palmar and a short dorsal flap (Figure 251) should be used whenever possible, but for amputation of an entire finger a racket incision (Figure 252) is very satisfactory If only one finger or the thumb can be saved,

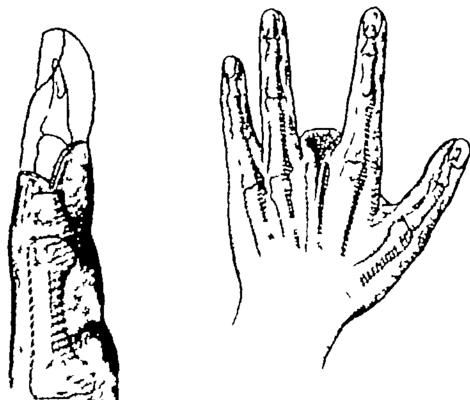


FIG 251 *Incision for Phalangeal Amputation*

FIG. 252. *Racket Incision for Disarticulation at Metacarpophalangeal Joint*

this should most certainly be done, because it is much more valuable than any artificial apparatus. Even if all the fingers and the thumb have to be removed, the stump is more useful in some respects than an appliance, and this is true also to a lesser degree of a carpal stump with all the metacarpals removed A prosthesis can be fitted to the carpus and the stump is of value even without an appliance. Disarticulation at the wrist is unsatisfactory from all points of view and is decidedly inferior to an amputation at the junction of the middle and lower thirds of the forearm (Figure 253) In amputations of the forearm and arm it is best to have the suture line over the end of the stump so anterior and posterior flaps of equal length are made In the arm the best level for amputation is in

the lower third above the condyles. The procedure in amputating the forearm or arm is essentially the same as that described under amputation of the thigh (page 656)

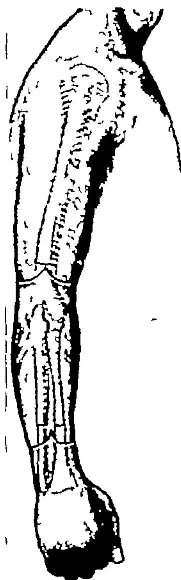


FIG 253 *Incisions and Optimum Sites for Amputation in the Upper Extremity*

Infections of the Hand

Lymphangitis Operative interference is contra indicated unless there is a localized collection of pus The extremity should be treated by continuous hot wet compresses and sulfonamide or penicillin therapy should be used. If abscesses develop in the regional lymph nodes, they should be drained This is true of any accessible abscess that may develop during the course of a septicemia.

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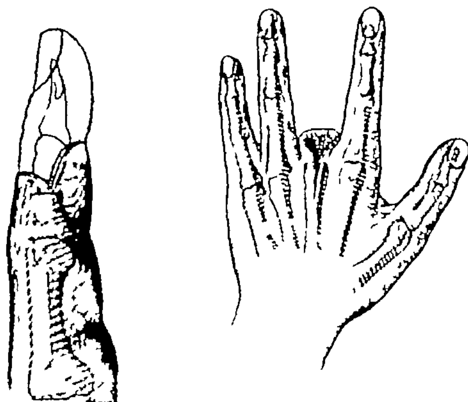


FIG 251 *Incision for Phalangeal Amputation*

FIG. 252. *Racket Incision for Disarticulation at Metacarpophalangeal Joint*

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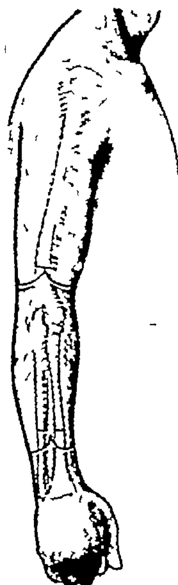


FIG. 253 *Incisions and Optimum Sites for Amputation in the Upper Extremity*

Infections of the Hand

Lymphangitis Operative interference is contra indicated unless there is a localized collection of pus. The extremity should be treated by continuous hot wet compresses and sulfonamide or penicillin therapy should be used. If abscesses develop in the regional lymph nodes, they should be drained. This is true of any accessible abscess that may develop during the course of a septicemia.

Paronychia When pus has formed, an incision should be made parallel to the nail on the involved side (Figure 254A)

Eponychia Minor infections in this location can be treated by pushing back the eponychium and inserting the point of a knife between the tissue and the nail

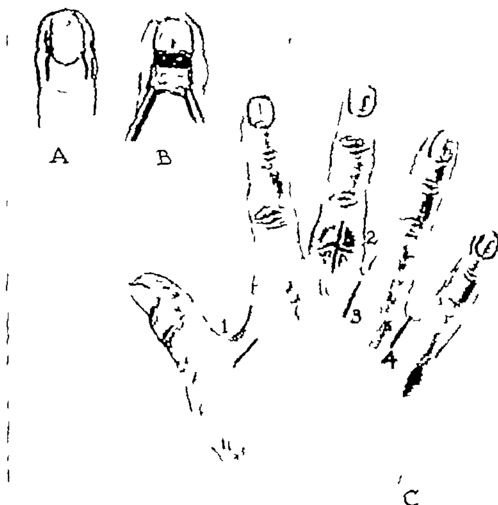


FIG 254 *Infections of the Hand.* A and B Removal of the base of the nail for subungual abscess. C–1 Incision for drainage of thenar space. C–2 Incision for carbuncle C–3 and C–4. Incision to drain infection that has spread to the dorsum from the middle palmar space.

Subungual Abscess An incision should be made along each side of the nail and the eponychium dissected up enough to permit removal of the proximal segment of the nail (Figure 254A and B) If the abscess is located in the distal part of the nail it should be uncovered by removing the overlying portion of nail. Any foreign body present should be removed.

Felon: An incision should be made on one side of the ball of the fi (Figure 255A) The knife should cut deeply into the tissues, ar necessary a similar incision may be made on the opposite side. Infec of the bone should be treated conservatively, but in some cases it wi necessary to remove the diseased phalanx or a portion of it. This sometimes be done through a lateral incision but often it is necessar make an incision around the end of the ball join the two lateral incisi dissect the flap of skin and tissue back and remove the bone.

Furuncle and Carbuncle A furuncle should be treated by hot dressings until it comes to a head, when it should be opened. If per lin and X ray therapy are ineffective a carbuncle should be widely cised by a crucial incision and the flaps should be undermined and tu backwards beyond the lesion (Figure 254C 2)

Infection of the Dorsum of the Hand When there is definitely lo ized pus underneath the skin a longitudinal incision should be n over it and drainage instituted using soft rubber drains. Pus in the de subaponeurotic space should be drained by one or more longituc incisions located well out on the distal portion of the hand (Figure 2 3 and 4) An incision is made through the skin with a knife and a cu hemostat is inserted to locate the pus underneath the tendons. Drai should be instituted, and the hand should be treated postoperativel hot wet dressings the latter procedure being used in all hand infect

Collar Button Abscess A superficial abscess of the palm of the h such as forms under a callus should be incised, but the possibility deep extension of the suppuration should be kept in mind and if ne sary deep drainage instituted.

Web-Space Infection In some cases an incision parallel to the d flexion crease of the palm over the point of swelling will give suffic drainage but if not, a longitudinal incision must be made across the extending as far toward the dorsum as is necessary to provide free charge of pus.

Infection of the Thenar Space An incision should be made on the sum of the hand between the first and second metacarpal bones (Fi 254C 1) After the skin has been incised, a curved hemostat is inse anterior to the adductor pollicis muscle into the thenar space the clan opened, and soft rubber drains are inserted.

Infection of the Middle Palmar Space An incision should be n medial to the distal end of the fourth metacarpal bone and exten proximally for 2 or 3 cm. (Figure 255B) A curved hemostat is inse beneath the flexor tendons into the space where it is opened up to a drainage of pus, and a drain is inserted. When the lumbrical canal la to the ring finger is involved, an incision may be made beginning at distal flexion crease of the palm and extending proximally on the la

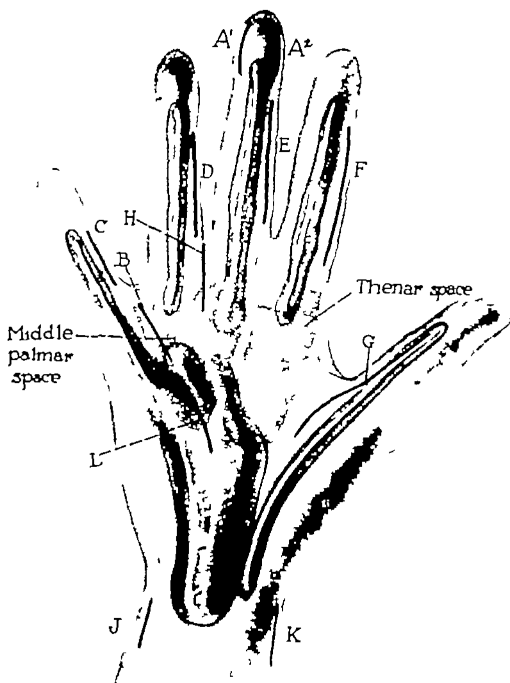


FIG 255 *Incisions for Infections of the Hand (Palmar Surface)* A-1 and A-2. Felon. B Infection of middle palmar space. C, D E, F and G. Tendon sheath infections H Lumbrical space infection J Major forearm space infection. K. Additional incision for forearm space infection. L. Infection in ulnar bursa.

saline solution should be used for three days. At the end of that time, hand or arm baths may be substituted for the wet dressings. Active and passive motion of the fingers and wrist should be begun as soon as pain will permit. A splint should be utilized when the infection has largely subsided, to keep the fingers in the best functional position and prevent contracture, but the splint should be removed frequently for finger and hand exercises.

CHAPTER XXX

Postoperative Treatment

Postoperative Treatment

The most important factors in the safe convalescence of the surgical patient are the skill and judgment with which the operation is performed, but good postoperative treatment further reduces mortality and morbidity shortens the recovery period, and lessens discomfort and distress.

GENERAL POSTOPERATIVE MEASURES

At the conclusion of the operation, a dressing is applied to the wound and held in place by adhesive tape. Before the tape is put on, the skin is wiped dry and the tape is applied snugly but not tightly in a transverse direction. The dressing should not be covered solidly with adhesive space should be left between the strips of tape to permit ventilation. The patient *is carefully transferred from the operating table to a stretcher and, after* being covered by a blanket, is taken to his room accompanied by the anesthetist or surgical assistant. In the room, the patient is gently moved onto the bed, where he is placed either on his side or on his back with the head turned to one side unless the nature of the operation makes these positions undesirable. A nurse should be constantly in attendance until the patient recovers from the anesthesia. Besides keeping close check on the condition of the patient, she removes wet clothing covers the patient with enough blankets to keep him warm but not too warm, and makes sure that there is sufficient airway for respiration. It may be necessary to pull the tongue forward or to aspirate secretions from the pharynx, and in many cases elevation of the foot of the bed on blocks helps bronchial drainage. This position is also useful when circulation is poor and after spinal anesthesia.

A sedative usually morphine sulphate in a dose of one-sixth to one-fourth grain, is administered every four hours as necessary to keep the patient comfortable. Usually it is advisable to give the first dose just as the patient is coming out of the anesthetic. After forty-eight hours, morphine can usually be discontinued and one grain of codeine given as required. To assure rest when there is no severe pain, the barbiturates are effective.

The position of the patient in bed should be changed every two hours during the day and as often at night as can be done without unduly disturbing his rest. At these times, the patient is encouraged to bend and straighten the arms and legs repeatedly to improve the circulation in the extremities, and a series of deep inspirations are advised. Carbon-dioxide inhalations are also given at frequent intervals during the first forty-eight hours.

It is usually advisable to begin the administration of fluids before the patient has recovered from the anesthesia. This fluid may be given by either the intravenous or the subcutaneous route. When transfusions are desirable, the blood may be started at this time. Usually 1000 cc. of 5 per cent glucose in normal saline is given by vein or 1500 cc. of normal saline by hypodermoclysis. The amount of blood administered will depend on the condition of the patient as shown by the pulse rate, blood pressure, and respiratory rate, and on the magnitude of the operation, degree of anemia before operation, and amount of blood lost during the operation. From one to four pints or more may be necessary. The fluid intake should be kept up to 3000 cc. per day in the usual case, but when there is loss of fluid by fistula, excessive sweating, or vomiting, 3500 cc. or more will be necessary. This fluid may be taken partly by mouth unless the nature of the operation prohibits it. In the usual case, water may be taken orally as soon as nausea has subsided, but after most operations it is necessary to provide other fluids by proctoclysis, hypodermoclysis, or venaclysis. The principles applied here are the same as those mentioned in the chapter on Preoperative Treatment.

Unless there is a contra indication, such as an operation on the stomach, the patient is permitted to take water but nothing else by mouth until the next morning, when he receives a liquid diet. On the following day, unless there is persistent vomiting, a soft diet is prescribed, and the patient continues on this until the fifth day, when the regular hospital meals are permitted.

A soap-suds enema is usually given on the morning of the third postoperative day, and following this a mild cathartic, such as milk of magnesia, is prescribed. After a few days the milk of magnesia may be discontinued and only mineral oil used if anything is necessary. In some cases a daily enema may be required until the patient is able to be up and about.

Early ambulation after surgery is desirable in the prevention of thrombophlebitis and pulmonary complications, but the patients must be individualized and no universal rules can be set down. The age and general condition of the patient must be taken into consideration, along with the nature of the operation and the type of incision. It is my opinion that during the first two or three days after a major operation, when there is nearly always some fever, the place for the patient is in bed, and that

getting him on his feet adds little that cannot be accomplished by deep breathing and leg exercises. At the end of that time the usual patient who has had abdominal surgery is ready and anxious to get up and when there is a muscle-splitting or transverse incision, or if non absorbable sutures were used, there need be little concern about the wound. The first period out of bed will necessarily be short, and consists of standing by the bed for a few moments, but the patient may be allowed up more frequently and for longer periods and with more activity on subsequent days, until he is ready for dismissal from the hospital on the seventh to tenth days.

TREATMENT OF THE WOUND

In the usual clean undrained case the dressing is not removed until the sixth postoperative day At this time the wound is inspected, and if it appears to be normal it is sponged off with alcohol or other antiseptic and a dressing is applied. On the tenth day the dressing is removed again and the dermal sutures are removed. The silkworm sutures are not removed until two days later in most cases. If the incision is small, the sutures may be removed on the sixth day at the time the wound is first inspected. When sutures have been placed in skin on an exposed part of the body where scarring is objectionable, they may be removed on the second to fourth day This is done particularly in wounds of the face and after thyroidectomy

When a drain has been left in the wound to take care of postoperative bleeding the dressing may have to be reinforced or changed the evening of operation and thereafter at frequent intervals. The drain is usually removed within forty-eight hours. If drains are used for a purulent infection, the dressing is inspected daily and changed as indicated. In such cases where frequent dressings are necessary ties are more convenient than simple adhesive strappings.

At the time the sutures are removed, or sooner if there is febrile reaction that may be due to the wound, under strictly aseptic precautions the wound is palpated for induration, which may be evidence of a collection of serum or a hematoma. In some cases the serum may be seen pointing in the wound as a small, bluish vesicle. In the latter case the vesicle may be opened, but if the serum or blood is located deeper in, it is better to aspirate it, inserting a needle some distance away from one side of the wound.

In removing sutures, the suture is grasped with a toothless forceps near the knot tension is made on the suture to expose a subcutaneous portion of it, and this is cut, after which the suture can be pulled out. If after one or more sutures have been removed it is seen that the wound is not sufficiently healed, the rest of the sutures should be left in and the wound brought together by flamed adhesive strips.

In removing drains — the time to remove them is mentioned under specific operations in which drains are used — it is better to pull the drain half way out on one day and completely out the next day, in order to keep the drainage tract from becoming immediately closed off. A safety pin is inserted through the drain after it has been pulled partly out, and the drain is cut off above the safety pin. The safety pin may be opened, inserted, and closed by using two hemostats, and is not touched by the fingers.

TREATMENT OF COMPLICATIONS

Wound Complications

The method of evacuating serum or blood that has collected in the wound has been discussed above. Infection of the wound is usually manifested by pain or an elevation of temperature, and this occurs most often from the fifth to the seventh days. When the dressing is removed at this time, inspection may reveal no obvious abnormality but on palpation an area of tenderness and induration is usually found without difficulty The pus should be evacuated by inserting a hemostat into the wound, cutting one or more of the sutures if necessary Frequently a soft rubber drain should be put in and left in place for a few days. Hot wet dressings aid in promoting drainage, and sulfonamides or penicillin may be administered.

Infection around the sutures is a common complication but usually produces little systemic reaction. Each suture may be involved, and where it penetrates the skin small collections of pus are seen. This condition is usually cured by removal of the sutures, but when it persists hot wet dressings are effective.

Diffuse inflammation of the wound in the form of a cellulitis may take place two or three days or later after operation. There is a severe systemic reaction, and the process may either be controlled by sulfonamides, penicillin, and wet dressings, or go on to a diffuse purulent infection. In the latter case the sutured layers of the skin separate and disruption is common. In the presence of pus, adequate drainage must be established, if necessary by cutting many or all of the sutures. The wound may then be supported by strips of adhesive plaster placed across it. Gangrene of the skin and gas-bacillus infection fortunately are rare complications. Their treatment is discussed in the chapter on The Skin and Subcutaneous Tissues.

Disruption may take place in a wound that has been the site of purulent infection with partial separation of the layers or it may occur in a wound that has apparently healed normally but in which actually little union of the layers has taken place Not infrequently the sutures are removed and the wound appears completely healed, but that evening or

the next day the patient feels something give way and there is often saturation of the dressing by brownish fluid. When the dressing is removed, evisceration is seen, or the loops of bowel may be visible at the peritoneal level The immediate procedure should be to place a sterile pad over the wound, force the bowel back into the abdominal cavity and hold the pad in place by adhesive If the patient is in good condition, he should then be transported to the operating room, where under general or spinal anesthesia the wound is closed by multiple through-and through sutures of silkworm gut or silk. All of the sutures are inserted before any are tied. Healing usually takes place satisfactorily but the sutures should be left in about two weeks.

When the patient's condition does not warrant the use of anesthesia, the wound should be strapped together by flamed adhesive tape, after removal of any sutures that have cut through and are serving no purpose The adhesive is flamed and applied in strips, leaving small gaps between the strips to promote drainage. When adequate closure of the wound can be obtained in this way no packing is necessary but in other cases the bowel must be held in the abdominal cavity by gauze and the wound strapped together over the gauze The gauze is left in place for several days. An abdominal binder should be applied over the dressing to give additional support. Adequate protein and vitamin intake should be assured to promote healing

Shock

The treatment for this condition is the same as that outlined in the chapter on Preoperative Treatment. When the shock is due to active postoperative hemorrhage, measures must be taken to stop the bleeding If the source of the blood is the wound itself it may be necessary to reopen the wound, find the bleeding vessel, and tie it. In other cases a mattress suture inserted around the point of hemorrhage is sufficient to control it. Internal hemorrhage following an operation is an extremely serious complication If conservative measures which include the use of repeated blood transfusions, are ineffective it is necessary to reopen the incision and to find and stop the bleeding In these patients, in the case of an abdominal operation, the peritoneal cavity is filled with blood, the major part of which should be removed. The field of operation is then re-exposed and search is made for the bleeding vessel. If the vessel cannot be identified and ligated, gauze packing may be sufficient to control the hemorrhage. Absorbable gauze will control an oozing surface and may also be used as packing Non-absorbable gauze packing is gradually removed after forty-eight to seventy two hours. An operation of this type should be made as brief as possible because of the high mortality associated with it.

Acidosis and Alkalosis

The principles of treatment for these conditions are outlined in the chapter on Preoperative Treatment.

Hypoproteinemia

See the chapter on Preoperative Treatment.

Anemia and Malnutrition

See the chapter on Preoperative Treatment.

Vomiting

Vomiting usually occurs following a general anesthetic and often after spinal anesthesia. Aside from nursing care, which consists in preventing inhalation of the vomitus by keeping the patient's head turned to one side or the patient on his side, and occasional aspirations of mucus from the pharynx, no treatment is needed. A certain amount of nausea often persists for twenty four hours, but vomiting beyond this period is an indication for the use of a Levine tube. The stomach may be lavaged from time to time by permitting the patient to drink water or soda water but the stomach should be kept empty by continuous suction. Fluids in the form of glucose or saline solution are administered parenterally until such time as the suction can be discontinued. The usual practice is to clamp off the tube, allow the patient to drink a little and see how he gets along. Since morphine often causes nausea, it may be wise to discontinue its administration, using pantapon or some other drug as necessary for pain.

Acute Dilatation of the Stomach

Occasionally during the early postoperative period, enormous dilatation of the stomach takes place with retained fluids and the development of dehydration and toxemia. A certain amount of vomiting is usually present but the stomach does not empty itself. The vomitus usually consists of greenish-brown liquid, but the gastric distention is due largely to gas and is apparently associated with a partial duodenal obstruction. As soon as the condition is recognized, a Levine tube should be inserted into the stomach and continuous suction provided. Turning the patient on the abdomen and elevation of the foot of the bed are helpful in relieving the duodenal obstruction. The dehydration, alkalosis, and loss of chlorides are treated by the use of parenteral fluids.

Adynamic Ileus

A degree of bowel paralysis usually follows any abdominal operation, but seldom lasts more than twenty four hours. If the paralysis of the bowel is severe and persists abdominal distention takes place due to the accumulation of gases in the intestine Enemata are ineffective and vomiting is frequent, with the vomitus soon taking on fecal characteristics. Loss of fluids and chlorides and hemoconcentration result.

Continuous duodenal suction should be instituted, or the Miller Abbott tube may be passed farther down in the bowel. The inhalation of 95 per cent oxygen by means of the Boothby mask promotes the passage of nitrogen from the intestinal gases into the blood and thence out by way of the lungs, and is beneficial in the treatment of gaseous distention. Chlorides, glucose and fluids should be supplied liberally by the intravenous route, and an amount of fluid should be given sufficient to keep the urinary output above 1500 cc. At least 3000 cc. of fluid is necessary per day and when duodenal suction is used more fluid is necessary because of the loss of the upper intestinal secretions. A record should be kept of the output of fluid by suction and allowance made for it. Suction is maintained until peristalsis is established and gas passed by rectum. At the end of this time, usually five or six days, the tube is clamped off for increasing intervals while fluid is allowed by mouth. When the clamp is removed, information is obtained in regard to the amount of fluid that has left the stomach. When the stomach appears to be emptying normally the tube is removed. Enemata and the rectal tube are valuable when peristalsis begins to return. This is true also in the case of prostigmine and pitressin.

Acute Parotitis

The treatment of this condition is described in the chapter on The Mouth, Tongue, and Salivary Glands.

Urinary-Tract Complications

Postoperative urinary retention is very common, especially after lower abdominal operations. If such measures as getting the patient in a standing or sitting position, running water into a basin, or giving an enema are not effective, catheterization should be done and repeated every eight hours until the patient is able to void. If the patient is still unable to void after several days, and catheterization is becoming increasingly difficult because of inflammatory swelling or an enlarged prostate an indwelling catheter should be inserted. During this period of drainage the bladder should be irrigated two or three times a day with 2 per cent boric acid solution The tone of the bladder muscle usually becomes re-established in a few days and the catheter can then be removed.

Acute cystitis should be treated by forcing fluids, irrigation of the bladder alkalinizing the urine by the administration of ten grains of sodium bicarbonate three times a day and giving sulfonamides or streptomycin. When streptomycin is used, 1 gm. is given daily in divided doses every three hours If there is any residual urine in the bladder catheterization must be done.

Acute pyelitis or pyelonephritis are also treated by liberal fluid intake, sulfonamides, or streptomycin and, particularly when sulfonamides are used, the urine should be alkalinized by administering sodium bicarbonate. Penicillin may be found more effective in some cases. Persistent fever or pyuria calls for urologic investigation.

Diminished output of urine is usually due to inadequate fluid intake or excess loss of fluid, such as occurs in prolonged vomiting or intestinal fistula. The lost fluid should be replaced by 5 per cent glucose or normal saline solution. Lowered blood pressure or cardiac failure commonly produces a diminished urinary output, and nephritis may be responsible. 100 cc. of 50 per cent hypertonic glucose solution injected intravenously is valuable in the treatment of anuria when it is not on a mechanical basis. In the latter case, cystoscopic examination should be done, with catheterization of the ureters and measures taken to relieve the obstruction, depending on its nature. It should be kept in mind that after the use of sulfonamides an obstruction of the renal pelvis or ureter may be produced by crystals of the drug This can be remedied by lavaging the renal pelvis with warm water and leaving the ureteral catheter in place for several hours.

Hiccough

Transient attacks of hiccoughing are common after operation and in most cases are of little concern, but when the condition is prolonged it is extremely uncomfortable and weakening to the patient. The most effective remedy is carbon-dioxide inhalations. The gas is preferably combined with 10 per cent oxygen and may be given by means of a mask and gas machine, or the patient may breathe it through a tube that passes through a water bottle and thence to a tank of the mixed gases. Inhalations are continued until hyperpnea is produced, the treatment being repeated every half hour or oftener In addition, sedatives such as barbiturates, bromides or morphine are of value. Hiccoughs may be associated with retention of secretions in the stomach. To relieve this, gastric lavage or continuous suction is indicated. Fluids should be supplied parenterally during the period of suction and also if there is continued vomiting Hiccoughs beginning several days after operation often herald extension of infection or a new focus of infection, and this should receive appropriate treatment. Penicillin is usually effective in such cases when surgery is not indicated. Phrenicectomy may in rare instances be justified in the

treatment of hiccoughs, but the operation or the less drastic procedure of procaine hydrochloride or alcohol injection of the phrenic nerves *should be reserved for those cases in which all other measures have failed* and where the hiccough is of major importance in the convalescence of the patient.

Thrombophlebitis

The treatment of this condition is discussed in the chapter on The Blood Vessels.

Acute Bronchitis

This may vary from the simple bronchial irritation, so commonly met with after surgery to a purulent infection of the bronchial mucosa, the latter usually being associated with a rise in temperature and profuse purulent expectoration. Steam inhalations, an expectorant cough mixture, frequent changes of position for the purpose of promoting bronchial drainage, and, in the febrile cases, penicillin or sulfonamides are indicated.

Bronchopneumonia

Penicillin or sulfonamides should be used in the treatment of this condition. If cyanosis is present oxygen is indicated. The usual medical regime in pneumonia is applicable here.

Pulmonary Atelectasis

The patient should be made to lie on the unaffected side and cough while in this position. If hips are elevated above the level of the shoulders by pillows, drainage of the bronchi is facilitated. As a rule the bronchial obstruction is relieved by this maneuver although it may have to be repeated several times but in occasional cases bronchoscopy with removal of the bronchial secretion by suction is necessary Pneumonitis associated with or following atelectasis should be treated by penicillin or sulfonamides.

Pulmonary Embolism

This condition is discussed in the chapter on The Blood Vessels.

TREATMENT OF COEXISTING DISEASES

Oral Sepsis

Mouth washes should be used at frequent intervals, the teeth should be brushed by the attendant, and, when there is dryness of the lips, petrolatum or cold cream should be applied. When the patient is not permitted to take liquids by mouth, gum chewing is helpful in promoting salivation.

Obesity

Because of the tendency of an overweight person to have postoperative complications, he should be watched with particular vigilance. Frequent breathing exercises should be encouraged and after an abdominal operation, distention should be treated immediately Fluid intake should be liberal and should include glucose especially when there is evidence of ketosis. The wound should be watched carefully for evidence of infection, and any liquefied fat which collects should be drained out. Sutures as a rule should be left in for a longer period of time, because of the more uncertain healing and the extra strain put upon the wound.

Diabetes

During the first two or three days after operation the diet is usually so limited that unless intravenous glucose is given there is no danger of the patient's exceeding his carbohydrate tolerance. During this period 80 gm. of carbohydrate is all that is necessary per day and if this amount is not taken by mouth it may be given in the form of glucose and administered in intravenous saline solution. The amount is best divided into two portions and given twice a day The aim should be to bring the patient up to the normal diet as soon as possible but this usually requires five or six days to accomplish. Examination of the urine is made every three or four hours and insulin is given as required. An adequate fluid intake and output should be maintained, the former mainly in the form of saline solution. The urine output which should be at least 1500 cc. per day should be examined for total glucose since this determination is of supplemental value to the fractional urine examinations made during the day Exact quantitative determination of the amount of sugar in the twenty four hour specimen is made, but in examination of the three-hour-specimens a report on the color of the reaction with Benedict's solution is usually sufficient for practical purposes. Determination of the blood sugar is necessary when there is danger of hypoglycemia, and in the presence of acidosis, when large doses of insulin are given the blood sugar value is helpful, as is also the value for the carbon-dioxide combining power of the plasma. In other cases, when the patient is very sick the blood-sugar level must be kept under exact observation. In general the treatment of diabetes in the postoperative patient is the same in principle as that in the non-surgical diabetic. Complicating factors are the inability of the patient to take the normal carbohydrate requirement during the first few days, and the rapidly changing insulin requirements as the diet is increased. With the onset of infection, also the problem of treating the diabetes is more difficult, in that even more careful observation must be maintained and more radical changes must be made in the insulin dosage, depending on the patient's response.

Nephritis and Hypertension

The urinary output of 1500 cc. or more per day should be maintained by giving an adequate amount of fluid either by mouth or by the subcutaneous or intravenous route. In the presence of nephritis, the salt intake, including that in normal saline solution, should be limited to 8 gm. per day because of the danger of producing edema. Five per cent glucose solution should make up the bulk of the parenteral fluid. Intravenous injections in the presence of hypertension should be given even more slowly than usual because of the probability of coexisting heart disease. Determinations of the non-protein nitrogen of the blood and the carbon-dioxide combining power should be made at intervals to detect increasing impairment of the renal function. In the presence of nitrogen retention the protein intake should be limited to 40 gm. per day.

Heart Disease

Postoperative coronary thrombosis is always a possibility in the older patient with heart disease, and pulmonary embolism is not too rare. Pulmonary congestion and bronchopneumonia also may be the result of myocardial weakness.

As soon as the patient has recovered from the anesthetic it is usually advisable to place him in a low Fowler's position but this position should be changed frequently and exercises of the extremities should be encouraged to prevent venous stasis. Oxygen therapy is of value when there is a low cardiac reserve even though no cyanosis or dyspnea is present. Decompensation of the heart should receive the same treatment in the postoperative patient as in others and the same is true of coronary disease. When fluids are necessary in the early postoperative period, they should be given subcutaneously or by slow intravenous injection. Usually only 500 cc. is given at a time and in congestive heart failure or coronary disease any fluid given by vein must be administered by the drip method and with extreme caution.

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